



AGRICULTURAL RESEARCH INSTITUTE
PUSA

THE
PROCEEDINGS
OF THE
LINNEAN SOCIETY
OF
NEW SOUTH WALES
FOR THE YEAR
1923
Vol XLVIII

WITH FIFTY-TWO PLATES
and 438 Text-figures

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CORRIGENDA

Through an error in numbering, the first two plates accompanying the paper by Marjorie I Collins in Part 3 of the Proceedings were numbered xv and xvi, which two numbers had already been given to the two plates accompanying the paper by Professor A Anstruther Lawson in Part 2

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PROCEEDINGS
OF THE
LINNEAN SOCIETY
OF
NEW SOUTH WALES.

WEDNESDAY, 28TH MARCH, 1923.

The Forty-eighth Annual General Meeting, together with the Ordinary Monthly Meeting, was held in the Linnean Hall, Ithaca Road, Elizabeth Bay, on Wednesday evening, 28th March, 1923.

ANNUAL GENERAL MEETING

Mr. G. A. Waterhouse, B Sc, B E., F E.S., President, in the Chair

The Minutes of the preceding Annual General Meeting (29th March, 1922) were read and confirmed

The President announced that the Council had conferred Honorary Membership of the Society on Professor J. P. Hill, D Sc, F.R.S., and Professor J. T. Wilson, M.B., Ch M., F.R.S.

PRESIDENTIAL ADDRESS

It is once again my duty to report to you on the work of our Society for the past year and to give a further account of the investigations I myself have begun and, in part, completed since I had the honour to address you twelve months ago.

Though I have been a member of your Council for a number of years and have always taken an active interest in its work, I now know that it is only when one occupies the Presidential Chair of this Society, that the fullest knowledge can be obtained of the more minute details of its activities. The last two years have shown me very clearly the strong position the Linnean Society holds not only in Australia, but throughout the whole civilized world, as proved by the demand for our publications from institutions and libraries abroad and by the extensive use made of our papers by scientists generally. Not only in regard to our publications do we hold a high position, but we are fortunate in the officers connected with our Society. Our Secretary, Dr A. B. Walkom, in addition to being a very capable Editor, holds a high position in his own special science

and has been asked by the University of Sydney to deliver, during the last two years, a short course of lectures on Fossil Plants as part of the third year course in Palaeontology. He has also found time for research work, and has undertaken the Editorship-in-Chief of "Australian Science Abstracts," an important quarterly publication instituted last year by the Australian National Research Council. The Macleay Bacteriologist and the four Linnean Macleay Fellows have all done good work during the year, to which more detailed reference is made in a later portion of this address. The Honorary Treasurer, Mr J H Campbell, will present to you to-night another series of balance sheets which show, as usual, the very strong financial position of the Society. Capital investments total nearly £80,000, in which the valuation of our freehold and buildings is only put down at the nominal sum of £105, whilst no credit is taken for the value of the library, which contains many complete series of scientific journals and many rare volumes that it would be very costly, in some cases impossible, to replace. The total assets of the Society amount very nearly to £100,000, a great portion of this being, of course, set apart, under the instructions of Sir William Macleay, for Bacteriology and the Linnean Macleay Fellowships.

We can look forward with confidence and pride to the future of this Society and to an ever increasing importance in the world's Council of science. In one respect our usefulness to science could be very greatly increased, and I think the time has now come when we might give most serious consideration to a change which has long engaged my attention. For some time it has been apparent to me that the use made of our excellent library is not commensurate with its value, and that our ordinary meetings are not so well attended as they should be. The reason for this is obvious. This Hall is so far from the centre of the city that consultation of the library and regular attendance at meetings call for an expenditure of time, which can be ill afforded by busy men and which can only be obviated by removing the Society's headquarters to a more accessible position. Sir William Macleay, that far-seeing and progressive man, would, I am sure, have been the first to appreciate the benefit accruing to the Society by such a move and it behoves us—his trustees—not to lag behind, but to emulate his great example by making as easy as possible the path of the working scientist, who, seeking no pecuniary gain to himself, places the knowledge for which he has laboured at the disposal of the community. Such a move as I have indicated is largely a question of finance, and I unhesitatingly affirm that any reasonable expenditure incurred to provide suitable premises in a convenient part of the city would be amply justified not only by an addition to our membership roll, but by an increase in the quality and quantity of our output. Let us make the Society still more worthy of its Founder!

The Australian National Research Council held its second general meeting in Sydney in August last. Of the many matters discussed at that meeting two are of more than ordinary interest to us as a Society, viz (1) the appointment of a committee to report on the matter of imposing control or restriction on the collecting and exportation of native animals, and also on the question of carrying out a Zoological Survey of Australia; and (2) the Pan-Pacific Scientific Congress to be held in Australia in August next. The Research Council has commenced the issue of a quarterly publication "Australian Science Abstracts," in which it aims to include short abstracts of all original scientific papers published by Australian workers since 1st January, 1922. This publication should be of inestimable value to future workers in Science in giving them a collected summary of the papers published by Australians in the various branches of science.

The sixteenth meeting of the Australasian Association for the Advancement of Science held at Wellington, N Z, in January was very successful, interest in the work of the sections being maintained at a high level. The next meeting is to be held at Adelaide in August, 1924, the change of month should be appreciated in view of the unfavourable climatic conditions likely to be experienced in Adelaide during January.

The Queensland branch of the Royal Geographical Society of Australasia has, during the past year, formed a Committee with Sir Matthew Nathan, Governor of Queensland, as Chairman, with the object of formulating schemes for the scientific investigation of problems connected with the Great Barrier Reef. The various scientific Societies, Universities, Government Departments and numerous other bodies that might be interested in the investigations were invited to appoint representatives on the Committee. A great deal of preliminary work has been done and Sub-Committees have reported on different aspects of the problem thus placing the Committee in a position to draw up concrete proposals before it asks for assistance in carrying out any or all of its schemes. Dr. Walkom is the representative of our Society and six other members of the Council are also on this Committee representing other institutions.

Though the Great Barrier Reef is so easily accessible there are so many problems connected with it which await solution that we can heartily offer our co-operation and wish the Committee success in its efforts.

The concluding Part of Volume xlvii of the Society's Proceedings has been issued. As was announced last year the volume is in five parts instead of four, the papers read at the ordinary monthly meetings forming Parts ii-iv. The complete volume (590 + lxxi pages, 58 Plates and 268 Text-figures) contains forty papers, covering the usual wide range of subjects, six of the papers being contributed by the Society's research staff.

The greater part of the work done on Natural History in Australia is undertaken voluntarily, much of it in the leisure hours of very busy men, and is published without expense to the community at large, the knowledge so published being readily available to anyone who may wish to make use of it. We are proud of the fact that a relatively large proportion of the research work in Natural History in Australia appears in our Proceedings.

Exchange-relations with kindred scientific societies and institutions continue to maintain a satisfactory level and, with the exception of a number of German Societies, our exchanges have now returned to pre-war conditions. Receipts for the past session total 2,120, the large number (as compared with 1,603 and 1,874 for the two previous years) being due in part to a valuable series of separates, numbering 545 in all, from the library of the late Mr J E Carne. In connection with the library I am also very pleased to be able to announce that in May last the Council was able to resume bookbinding operations, and that so far about 300 volumes have been bound. This is considerably more than the number of volumes received in one year, that require to be bound, and by proceeding steadily it is hoped gradually to overcome the arrears that have accumulated during the past ten years.

During the past year the ordinary procedure at meetings was varied on several occasions, by the delivery of lectureries illustrated by lantern slides, and by giving members an opportunity of discussing papers after they had been published in the Proceedings. For the lantern lectureries we are indebted to Mr. A. R. McCulloch for a very interesting account of Lord Howe Island and to

Mr J Ramsay for illustrations of the results of timber cutting in the National Park. In connection with the matter of timber cutting in the National Park, the Society was represented on a deputation arranged by the Ornithological Section of the Royal Zoological Society of N S W, to the National Park Trust, to protest against allowing timber in the Park to be cut for milling purposes.

By the resignation of Messrs R T Baker and J H Maiden the Council has lost two members who have rendered the Society valuable services. Mr Baker was a member of Council for 25 years and Mr Maiden for 35 years.

I have much pleasure in offering the Society's heartiest congratulations to Mr E C Andrews on the honour conferred on him by his election as an Honorary member of the Washington Academy of Sciences, Mr R T Baker on the award of the Clarke Memorial Medal by the Royal Society of New South Wales, Mr H G Smith on gaining the David Syme Research Prize of the University of Melbourne, Mr J H Maiden on the award of the Mueller Medal by the Australasian Association for the Advancement of Science, Mr W M Carne on his appointment as Government Botanist of Western Australia and Lecturer on Plant Pathology in the University of Western Australia, Professor L Harrison on his appointment to the Chair of Zoology in the University of Sydney, Professor E J Goddard, a former Linnean Macleay Fellow, on his appointment to the Chair of Biology in the University of Queensland, and Mr A N Burns, one of our youngest members, who has been appointed to the Prickly Pear Commission, where we wish him a successful entomological career.

Since the last Annual Meeting the names of eight Ordinary Members have been added to the roll, six members have resigned, the names of two have been removed from the list and we have lost by death*four ordinary members. This leaves us with a membership at the present time of 158.

JOSEPH EDMUND CARNE, who died on 23rd July, 1922, was born at Melbourne in 1855. He was the second son of Joseph William Carne, who was the second son of Captain T Carne of the 46th Regiment which landed in Australia in 1814. After the death of his mother in 1871, he went with his father and three brothers to the Riverina, where they engaged in droving work until the father's appointment as Government Appraiser of Rents in the Riverina. Later they went to the newly-opened goldfields at Gulgong, staying there two years, but they did not meet with success and the father took up auctioneering, the boys turning their hand to anything that offered. After a time they returned to Strathfield and later all five and another brother went to Currawillinghi in Queensland where J E Carne worked on the station of Henry Hammond. Having been offered a position on his uncle's station, Glentworth, near Deniliquin, he rode there overland. While droving stock from this station to the Diamantina and Cooper Rivers, he contracted sandy blight so severely that he nearly lost his sight. He was laid up with this for some weeks and then set out for Sydney for treatment, riding some 270 miles to pick up the Hungerford to Bourke coach. Under treatment his eyesight improved but was never again quite normal. At Strathfield he met Mr C S Wilkinson, the Government Geologist, and having become interested in geology he was appointed personal assistant to Mr Wilkinson on 3rd January, 1879. On his appointment, his special work was the preparation of a geological and mining exhibit for the Sydney International Exhibition, 1879 and Melbourne Centennial Exhibition, 1881. Mr Carne's preparation of these exhibits was so successful that he was later entrusted with the preparation of similar exhibits for a number of important international exhibitions, including the New Zealand and

South Seas Exhibition in 1889, the International Exhibition of Mining and Metallurgy in London, 1890, and the World's Columbian Exposition at Chicago in 1893

The collections saved from the Garden Palace fire in Sydney in 1882, were used to form the nucleus of the Geological and Mining Museum, of which Mr Carne was appointed the first Curator. In 1893 he was appointed Geological Surveyor, in 1902 Assistant Government Geologist, and in 1916 Government Geologist. Early in 1912 he joined an official expedition to the Purari Coalfield, Papua, the Prime Minister having asked for the services of one of the geological staff of the Department of Mines of N S W, to examine and report on this field. He spent some five months in Papua, during which he visited not only the Purari Coalfield, but also the sites of reported oil-seepages. The results of his observations were published as Bulletin No. 1 of the Territory of Papua. Notes on the occurrence of Coal, Petroleum and Copper in Papua. Unfortunately, during this expedition, he contracted malaria severely, the effects of which were responsible for the unsatisfactory state of his health during the remainder of his life. He retired from his post as Government Geologist in 1921.

Mr Carne's official geological work covered a very wide range of subjects, and in all his published work there is evidence of the thoroughness which was one of his outstanding characteristics. He was primarily responsible for the publication, by the Geological Survey, of the very important series known as "Mineral Resources" to which he himself made a number of notable contributions including those dealing with Copper (1899, second edition, 1908), Tin (1911), and Limestone (with L. J. Jones, 1919). His two other outstanding works were published as memoirs of the Geological Survey of N S W, dealing with the Western Coalfield, and The Kerosene Shale Deposits of N S W respectively. For his contributions to the geology of New South Wales he was in 1920, awarded the Clarke Memorial Medal by the Royal Society of N S W, the highest honour which that Society can bestow on a scientist. He was a member of our Society for 23 years, and a member of Council from 1913 to 1921.

CHARLES OSWALD HAMBLIN, who died as the result of an attack of double pneumonia on 2nd October, 1922, was born at Bathurst in 1893. Matriculating from the Sydney High School, he entered the Faculty of Agriculture in the University of Sydney in 1912, and graduated with First Class Honours, in 1915. In addition to the degree of B.Sc. Agric, he also obtained the degree of B.Sc. with First Class Honours and medal in Botany and Second Class Honours in Zoology. In 1913 he entered the service of the Department of Agriculture as a cadet. Enlisting as a member of the 9th Field Ambulance in September, 1915, he was later transferred to the 34th Battalion with the rank of First Lieutenant. He remained on active service till the cessation of hostilities and returned to Sydney in 1919. Shortly after his return we had the pleasure of welcoming him at our meetings. He became a member of the Society shortly before his enlistment in 1915. In 1919 Mr Hamblin was appointed Assistant Biologist in the Department of Agriculture and in 1922 he was promoted to the position of Principal Assistant Biologist. By his death, agricultural science has lost one of the most promising of its younger school of research workers. The results of his researches, which gave the greatest promise in the field of plant pathology, were all published officially and include papers on Downy Mildew of the Vine, Flag Smut, Spotted Wilt of Tomatoes, Foot Rot of Wheat, and Collar Rot of Citrus Trees.

Mr Hamblyn was one who, besides being intensely interested in his research work, was willing to give up portion of his time to the administrative work which is a necessary portion of the activities of scientific societies. He was one of the Honorary Secretaries of the Section of Agriculture of the Royal Society of N.S.W., and a member of the Council of the Naturalists' Society of N.S.W. The Department of Agriculture has been singularly unfortunate in losing two brilliant young scientists, both doing valuable research in plant pathology, for Mr Hamblyn's predecessor, Mr Harry Stephens, was killed on active service at the age of 27.

GEORGE ISRAEL PLAYFAIR, who died at Tauranga, N.Z., on 8th October, 1922, in his 52nd year, was educated at Nelson College, Kent and Silcoate's Hall, York-shire, England and started as a school teacher in England. He came to New South Wales in his twenty-second year and became a tutor, first to a family near Goulburn and later near Orange. It is believed that during this period he first became interested in Desmids, on which group he afterwards did a great amount of research. From Orange he returned to Sydney and while acting as a secretary he used his leisure to collect systematically, being, however, hampered in his studies by the difficulty of obtaining books to aid him in the identification of specimens. He then spent two years as accountant at some phosphate workings off the coast of Queensland where, having a good deal of spare time, he employed himself in working steadily at his collections. He returned to Sydney, as far as can be gathered, early in 1900. Having a deep and sincere religious bias, he took over the Pastorship of the Auburn Congregational Church in the latter part of 1900, as an extra-mural student under the Rev E. T. Dunstan, of the Pitt Street Church, who was at that time Chairman of the Union. He remained in charge at Auburn until March, 1905, when he went to assist the Rev E. T. Dunstan who had started "Whitefields" Church in Pitt Street. After a time he assisted the Presbyterian Minister at Muswellbrook, but returned to Sydney and again took over the Pastorship at Auburn, with which, after about five years' work, he finally severed his connection in July, 1912. He was not ordained. In 1912 he applied for and was awarded one of the newly instituted Government Research Scholarships at the University of Sydney. This he held until 1918, carrying out his work at Lismore. In Lismore he retained his interest in Church matters and particularly in all movements for the betterment of children. After finishing with his Scholarship, he was teaching for a time at Murwillumbah. In 1921 he suffered a very serious illness and on his recovery he went to live with his brother in New Zealand. He never became quite well again and passed away quietly, having managed to complete the manuscript of a last paper but only rough sketches of the illustrations. He had been a member of the Society since 1908.

His published researches include thirteen papers in our Proceedings between the years 1907 and 1921, and one paper to be published during the coming year, as well as Supplement No. 1 to "A Census of New South Wales Plants," comprising a census of the freshwater algae of N.S.W. The greater part of his work was on the lower groups of freshwater plants, in which sphere he was almost a solitary worker in Australia. Perhaps the most important of his work was that on the Desmids and his insistence on the prevalence of polymorphism in this group, as a result of his study of these plants he concluded that of about 250 described "species" found in and around Sydney, some 200 were polymorphic.

forms of the other 50 His drawings in illustration of his papers were always particularly fine and when we remember that he suffered a good deal from rheumatism and that these drawings necessitated cramped positions for prolonged periods, which caused him much pain, we may realise a little the extent of his enthusiasm for his work

From 1907 to 1912 he was in honorary charge of the Freshwater Algae in the National Herbarium at the Botanic Gardens, Sydney, and on his removal to the country the Director pays a tribute to his work in this section (Ann Rept. Syd Bot Gard 1912 (1913), p 19)

It is difficult to obtain information regarding Mr Playfair's life, for he was one of those who was always willing to talk freely of his work, but said little about himself Those who knew him well speak enthusiastically of his personality and of his enthusiasm for anything in which he was at all interested

JOHN SHIRLEY, who died on 4th April, 1922, was born at Dorechester, England, on the 11th August, 1849 Before coming to Australia he took the degree of Bachelor of Science of the University of London and qualified as a teacher, in which profession he won some distinction at Bishop Ryder's School in Birmingham He landed at Brisbane in 1878, being one of a band of British teachers brought out by the Queensland Education Department He was appointed headmaster of the State School at Roma in 1878, and remained in the service of the Education Department till 1919, when he was retired During this period of about forty years his duties took him over the greater part of Queensland, of which State he saw far more than falls to the lot of most men In 1879 he was appointed to an inspectorship, serving successively the following districts: i the country at the back of the Mary R Valley (a district which involved some 4,000-5,000 miles riding annually), ii the Northern district, extending from Gladstone to the Gulf of Carpentaria, iii the Darling Downs and iv South-east Moreton In 1909 he was appointed Senior Inspector and in 1914, on the establishment of a Teachers' Training College in Brisbane, he was selected to fill the important post of principal and he guided that institution till his retirement In 1920 he was appointed conchologist to the Queensland Museum (a post which he had filled previously in an honorary capacity) but in less than two years the position was done away with

Dr Shirley's achievement in obtaining the degree of Doctor of Science at the age of 63 must be unique Few men would face the ordeal of the examination for which it was necessary to sit, in addition to the preparation of a thesis, at such an advanced age His thesis was entitled "The thallus of the genus *Parmelia*"

One of the older school of men interested in natural history, Dr Shirley's activities covered a wide range. His life as an inspector of schools in the country districts of Queensland gave him ample opportunity of satisfying his interests in botany, zoology and geology and he made good use of these opportunities. His published researches deal mainly with botany and conchology and most of them appeared in the Proceedings of the Royal Society of Queensland before which he read more than forty papers

For very many years Dr Shirley was one of the most prominent figures in the scientific life of Queensland He joined the Royal Society of Queensland on 3rd December, 1886, and was a member of the Council of that Society from 1887 till his death, twice President, as well as Hon Secretary and Hon Treasurer at different times. He had also been Queensland Secretary for the Australasian

Association for the Advancement of Science since 1891, a member of the Field Naturalists' Club of Queensland; and a corresponding member of the Royal Society of Tasmania. He compiled the Queensland portion of the International Catalogue of Scientific Literature. He had been a member of our Society since 1911.

Australian Science suffered a severe loss by the death of Professor James Arthur Pollock who, though not a member of this Society, was intimately associated with the scientific life of the community. He had occupied the Chair of Physics in the University of Sydney since 1899, and had a very high reputation as a physicist, results of his experimental work being contained in some twenty published papers. He was President of Section A of the Australasian Association for the Advancement of Science in 1909. For the last eleven years of his life he was one of the honorary secretaries of the Royal Society of New South Wales, taking charge mainly of the editorial side of the work. In 1916 he was elected a Fellow of the Royal Society of London. During the war he rendered distinguished services to his country, more particularly in the design and operation of listening devices for trench warfare and tunnelling, and later in experiments for deciding problems of navigation at high altitudes and among clouds.

The year's work of the Society's research staff may be summarised thus,—

* Dr R. Greig-Smith, Macleay Bacteriologist to the Society, submitted a second paper upon the activities of the high temperature organism which is used in carbonating the lead in the process of White Lead manufacture. Enquiry was made regarding the components of the tan-bark that are fermentable and the conclusion arrived at was that the chief substance fermented is humic acid. Before being again used in the fermentation stacks, the spent bark is subjected to a treatment known as tempering in which moulds visibly play a part. From the tempered bark several moulds were isolated and these had the power of attacking cellulose, converting it into substances which were readily fermented by the high temperature bacillus. The tempering thus brings about a revivification of the spent bark through members of the mould flora converting the inert cellulose into fermentable material. The paper will appear in the Proceedings for 1923, Part 2. Other matters connected with the activity of the high temperature organism have been under investigation. These include the fermentability of sugars and other comparatively simple organic substances. It was found that organic salts such as citrate were sometimes fermented and were sometimes not. The reason for the irregularity is being sought. The enquiry into the cause of the formation of nodules at the bases of the stems of Eucalyptus seedlings was resumed and the matter has advanced a stage. Dr Greig-Smith has succeeded in obtaining in test-tubes, growths of vegetable substances which appear to be similar to or identical with the tumours obtained by Dr Erwin F. Smith in his work upon the Crown Gall of Plants. Histologically, these test-tube tumours show much the same structure as E. F. Smith depicts in his works upon Crown Gall. A Rhus-like organism has been isolated from one of the actively growing tumours and its activities are under investigation.

Dr J. M. Petrie, Lannean Macleay Fellow of the Society in Biochemistry, has, during the past year, commenced the investigation of the natural colouring substances of the flowers of various Australian plants. Preliminary experiments were carried out on the flowers of *Eucalyptus corymbosa*, *Acacia discolor*, *Acacia limicola* and *Persea pinnifolia*, and as a result of these experiments, *Acacia dis-*

color was selected for more complete examination. This preliminary work was valuable in enabling Dr Petrie to formulate methods by which he might obtain most successful results in his subsequent work. Flowers of *Acacia discolor* were collected at various times and from a number of localities in the neighbourhood of Sydney. The colour pigment was found to be in the group of water-soluble substances and therefore not connected with the chlorophyll group. The yellow pigment is closely associated with the tannins, both in constitution and in those properties generally used in their separation.

Further work has resulted in the extraction and isolation in the pure state of the water-soluble yellow pigments of *Acacia discolor* and *A. limfolia*. Comparison of the properties and compounds of these two pigments indicates that they are probably identical. The yellow colouring matter has been found to exist in the plants in the form of glucosides and experiments are now in progress to identify the sugars which are split off from the pigment during decomposition.

Unfortunately Dr Petrie's work was interrupted during the year for a period of about three months by a severe attack of bronchial pneumonia.

Miss Vera Irwin Smith, Linnæan Macleay Fellow of the Society in Zoology, completed, during the earlier part of the year, her studies of the Nematode genus *Physaloptera*, the results being contained in three papers forming Parts 2, 3 and 4 of this series, a fourth paper on Nematodes contained a description of a new parasite of a lizard. These four papers appeared in the Proceedings for 1922. On finishing this work Miss Smith returned to her studies of life histories of Australian Diptera Brachycera, and spent the remainder of the year in a thorough investigation of the respiratory system in the larva, pupa and imago of *Metoponia rubriceps*. This piece of morphological work has been carried to completion and the results embodied in a paper which will appear in Part 2 of the coming year's Proceedings. This important piece of work should form a valuable addition to the series of papers already published.

Miss Marjorie I. Collins, Linnæan Macleay Fellow of the Society in Botany, has continued her investigation of the vegetation of the arid and semi-arid regions of New South Wales. After completing the laboratory examination of the material collected in the Barrier District she proceeded to Cobar and spent some time in field-work there. Field observations were made in the immediate vicinity of Cobar, as well as in sandstone and quartzite country at Tullagoonah, 75 miles from Cobar, and on the black soil country of the Darling River Basin. The results of these observations should prove of great interest when compared with those made in the Broken Hill area. On her return from Cobar, Miss Collins commenced the preparation of the first of a series of papers on the vegetation of the areas visited, but before completing this she deemed it advisable to pay a second visit to the Barrier District in order to observe it under drier and more typical conditions than those of the previous year. On this occasion she visited the Grey Range near Milparinka and the sandhill and claypan country west of Yandama. The results of all these investigations are now being prepared for publication.

Miss Marguerite Henry, Linnæan Macleay Fellow of the Society in Zoology, has continued her studies of the freshwater entomostraca of New South Wales. Two papers have been published during the year, the first, embodying the results of the examination of the Cladocera, appearing in Part 2 of the Proceedings for 1922, and the second, dealing similarly with the Copepoda, in Part 4. A third paper dealing with the Ostracoda is also practically complete and will appear in

the coming year's Proceedings. In addition to this descriptive work, Miss Henry has also prepared a number of aquaria in which she is making observations on the life histories of several species. Further collections of Entomostraca have been received from Yass and Myall Lakes, and also samples of dried mud from Lake Eyre and near Cobar.

Dr Walkom, in continuation of his investigations on the fossil plants of Eastern Australia has been occupied with preliminary work on (1.) the flora of the Star Series of Queensland, a Carboniferous or possibly Upper Devonian flora of which the majority of the specimens available belong to *Lepidodendron*, and (2.) the flora of the Narrabeen Series of New South Wales and he hopes during the coming year to complete both these pieces of work. During the past year, after much delay, the Queensland Geological Survey issued the results of his work on the *Glossopteris* floras of the Lower and Upper Bowen Series in Queensland.

Three applications for Linnean Macleay Fellowships, 1923-24, were received in response to the Council's invitation of 27th September, 1922. I have pleasure in reminding you that the Council has re-appointed Dr J. M. Petrie, Miss Marjorie I. Collins and Miss M. Henry to Fellowships in Bio-chemistry, Botany and Zoology respectively, and, on behalf of the Society, I wish them a successful year's research. Miss Irwin-Smith leaves us with the intention of visiting some of the zoological laboratories in England. We wish her a pleasant and profitable time.

Biological Survey of Australia

Last year I brought before you the necessity for a Zoological Survey of Australia and pointed out that the sister Sciences of Geology and Botany had been recognised in the various States by the institution of special Departments and the appointment of expert officers, who were in a position to speak authoritatively of the requirements of their respective Branches. In the case of Zoology no general systematic study has been undertaken, except in the case of Economic Entomology, each State having an Entomologist attached to its Department of Agriculture.

The land and marine fauna was almost everything to primitive man who, like the Esquimo to-day, was entirely dependent on the results of the chase for his whole livelihood—food, clothing, fuel, and utensils. With increased pressure of population and growth of civilisation, man commenced to cultivate vegetables. By degrees he passed from hunting to farming and was able to obtain all he needed in the way of food, fuel, shelter and clothes from the vegetable kingdom, as some races do even to-day. Another advance was made when mankind discovered metals, the ownership of iron carried with it victory—the overlordship of the world. We are now at the beginning of another cycle when Zoology is taking its own important place in the economy of the world. In our own generation it has been learnt that micro-organisms are mightier for weal or woe than any other factor of our environment; that friends or foes of animals may decimate us with sleeping sickness or bubonic plague; thus the humblest organism may become of the greatest importance. The rat, as the host of the flea, has become an important creature to man, as also have the mosquito and the fly. On these grounds alone, a Zoological Survey of the land we live in is a work of prime necessity.

Our animals have been sadly neglected; the number of the larger species is not great, and they are not of use for domestic purposes. Speaking of the marsupials alone—the fur can be put to commercial uses and as a result they have been shot to such an extent that many species have been well nigh exterminated. It is for their scientific importance that they should be preserved, as representing a group found, with very few exceptions, wholly within Australia. Of late years letters have continually appeared in the press drawing attention to the wholesale export of our marsupials and birds (both skins and live specimens), but little has been done in this matter. Too many departments are concerned and none has complete control. There are laws that aim at preventing shooting and trapping but still the slaughter goes on, export is controlled by permit, but there appears to be little restriction of these activities. The scientific importance of our fauna is shown by the number of expeditions that have visited or propose to visit Australia and very soon it may be said that the best collections of some groups are to be found not in Australian Museums, but in those outside Australia. This should not be so, our Museums should aim, first of all, to exhibit, not the fauna of other lands, but that of our own country, of which unfortunately our people seem to have far too little knowledge. It is the land fauna that is being destroyed, the marine fauna, with perhaps such exceptions as the seals, will be much the same 500 years hence. We should be up and doing and study and preserve the land fauna whilst we have it with us.

It behoves this Society to ask how has this happened and can the position be rectified. In New South Wales there are two institutions that might be expected to take a keen interest in these questions—The Australian Museum and Taronga Zoological Park—neither of them government departments but governed by Trustees, and in both cases Zoologists are in a decided minority on the Trusts. Mere zeal of the business man is not to be compared to the technical knowledge of the man who may not be so prominent in Society. The Australian Museum is working under an old act and from the meagre material then available the Government of the time no doubt made the wisest choice, but to-day the community contains many highly trained and qualified men whose services might readily be availed of. For instance, why should the Chief Justice, The President of the Medical Board, The Crown Solicitor, as such, be Trustees and not the Professor of Zoology at the University of Sydney or representatives elected by this Society or the Royal Zoological Society. The attendance of members of the Trust, as shown in the last Report of the Trustees, shows that alterations in the constitution of this Trust are decidedly necessary. The National Park Trust is in the same state, several members of that Trust not having attended a meeting for two years. The Minister for Lands promised that a representative of this Society should be appointed to the National Park Trust but so far nothing has been done. As regards Taronga Zoological Park, it is generally supposed, and naturally so, that even if the Royal Zoological Society does not control the Park, at least it has some representation on the Trust, but this is not the case. If the present system of Trusts is thought to be the best, which I doubt, they should be reconstituted on modern lines and institutions included that rightly might be expected to have technical knowledge useful to the Trusts. I believe, however, that the Australian Museum, as is the case in one at least of the other States, should be constituted a government department responsible either to the Minister for Education or the Minister for Agriculture. The Botanic Gardens does not

have an unwieldy Board to control the Director, and some similar form of government would probably benefit Zoology considerably

To deal with our fauna in all its aspects, I would beg to suggest the abolition of all Trusts in connection with zoological matters and that the institutions concerned, controlled by their own responsible officers, be placed under some suitable government department. Then an honorary Advisory Board should be established to report to the government on all general matters dealing with our animals. Such questions as the preservation of the existing fauna, the Birds and Animals Protection Act, the Zoological Survey, the issue of permits to collect, the export of live animals or skins, might be referred to such a Board, which would consist of those government officials such as the Director of the Museum, the chief of the Stock Department, the Government Entomologist and the Director of Taronga Park, together with the Professor of Zoology at the University and direct representatives of Scientific Societies and perhaps a representative from the Customs Department. Such a Board would be quite capable of expressing a definite opinion on any zoological question that might be submitted to it by any of the Government Departments and, as time went on, from this might readily develop a Zoological Survey for the whole of Australia.

Not must we forget that in an attempt to preserve our fauna the flora plays an important part, the fauna cannot exist without the flora. Within very recent times as a result of drainage in a particular part of England, one species of butterfly has disappeared. Not only for the benefits our forests confer on our animals, not for the commercial value of their timbers, should they be preserved, but for their own beauty and their use in purifying the atmosphere and providing shade in the heat of the day. What is more unpleasant than a dusty country town, treeless and bare, the other side of the picture, however, brings pleasant memories of several country towns we have visited.

One of our members (Mr. T. G. Sloane) has lately urged in the press, the necessity of preventing the destruction of the trees of the whole of the area of New South Wales that exists above 4,000 ft. This area is unfortunately not of very great extent and will in the future, if preserved, be a valuable asset, but, if unintelligently denuded of trees, will be a menace to us. These highlands are the gathering grounds of our rivers, our future health resorts, and from the rivers that rise there we will in the future obtain our electrical supply. Let us see that these are preserved from such destruction as will prevent them being of use to future generations. I well remember my first journey to Mt. Kosciusko—then a two days' trip from Sydney—the final stage being on a cattle horse and leading a pack horse, now this nature's paradise for zoologist and botanist can be reached in comfort in about 18 hours from Sydney. Another area above 4,000 ft, almost of equal importance and but little known, is that long spur from the Main Divide—the Mount Royal Range, the view from certain portions of which is truly magnificent, at present difficult of access, it could readily be put into easy communication with the cities of Newcastle and Maitland and the towns of the Upper Hunter. Its Natural History wonders have only yet been partially explored. I will never forget the trip I made to Barrington Tops last year, guided by our fellow member, Mr. J. Hopson—the delight in the invigorating atmosphere, the wonder at the country passed through, the teeming insect life of the Tops and the enrichment of my own collection. As evidenced by the letters appearing in the press of late, the general public are awakening to an in-

terest in the preservation of our fauna and flora and it behoves us who study them to lead the way and do our best to pass on to our descendants the inheritance we have received, as little impaired as the development of this glorious Australia of ours will allow

A further account of breeding experiments with the Satyrine genus Tisiphone

In my address to you last year I showed, by experiment, that the interesting and variable race of *Tisiphone abeona* called *joanna* was a natural hybrid between the broad orange-banded southern race and the narrow cream-banded northern race

Since our last meeting I have conducted many further experiments with these butterflies on the lines indicated previously, but in most cases they are not sufficiently far advanced to discuss, or to compare with the previous experiments. I succeeded last year in obtaining thirteen successful pairings with *abeona* and *morrisi*, the larvae of the latter being obtained near Wardell, Richmond River and, chiefly, from Urunga, at the mouth of the Bellinger River. The number of fertile eggs was considerably larger than on the previous occasion and, though all the larvae have not yet pupated, I expect to obtain more first generation butterflies than the one hundred secured with the first experiment. Already I have obtained 101 first generation hybrids which I exhibit to-night and have about 30 pupae yet to emerge. The experimental cages, the cost of which was defrayed by a grant by the University of Sydney from the McCaughey Research Fund, have proved a great success. The food-plant of the larvae (*Gahnia*) grows, if anything, too vigorously and I have introduced several restraints in manipulation. Already I have begun to make my pairings to produce the second generation of butterflies and have been very successful. I have this time paired one of the first generation females with a male *abeona* and a male of the first generation with a female *morrisi*, also I have paired a male and a female from the same first generation family, in addition to nine pairings, of which the sexes came from different first generation families. It will thus be seen that I have somewhat extended the scope of the experiments and, when the whole range of experiments is completed, I will have a vast amount of material on which to base my conclusions. I suggested last year that interesting and important results would accrue if it were possible to rear a family of the Port Macquarie race *joanna* from known parents. Unfortunately, my visit to Port Macquarie last Easter did not yield me sufficient larvae to make this experiment, but I brought back two females alive, both of which laid fertile eggs. One of these, of the cream type, only laid 9 eggs which gave me five butterflies which are shown to-night. Unfortunately, through an accident, the female escaped and was lost. This female had probably laid several eggs before her capture. The other female was of the orange type and had probably not laid any eggs before I caught her, on 17th April, 1922. During 18th and 19th April she laid 14 eggs from which I reared 12 butterflies (Plate II, figs 4-15). These are shown with their mother (Fig. 2) on Plate II and are exhibited to-night. Plate II also shows a male *abeona* (Fig. 1) and a male *morrisi* (Fig. 3) for comparison and I propose to discuss briefly this family to-night.

For convenience of comparison Plate III, issued with my address last year, is repeated and accompanies this address as Plate I. This plate consists of hybrids between the races *abeona* and *morrisi* belonging to the first, second and third generations, and were shortly discussed in my remarks last year.

In the following descriptions only the upperside is taken and the coloured markings are described in detail. The ground colour of the wings in freshly emerged specimens is nearly black, but soon becomes duller and browner with age, the two ocelli on both fore and hindwing are always darker than the ground colour, being jet black, and not fading with age as in the case of the ground colour. These ocelli are the first portions of the wing to show any colour when the pupae are darkening preparatory to emergence. The subapical ocellus is usually about one-third the diameter of the subterminal on both wings, they all have a white pupil, dusted in varying degree with blue scales, which are more or less extensive on the subterminal ocellus of the hindwing. The subapical ocellus of the hindwing is the least developed of the four and is sometimes obscured. For convenience, the specimens on Plate II are described in order of emergence.

Fig 1 *T. abeona* male, emerged Sydney, 4th Nov., 1922. Forewing Ocelli not encircled by any colour, a faint subapical orange bar between subapical ocellus and end of cell (this bar is more prominent in the female), a broad orange band from vein 1 to vein 11, narrower where it curves round the subterminal ocellus and forming a well defined bar across cell. Hindwing Subapical ocellus usually faint, more prominent in female, subterminal ocellus prominent, surrounded by a dull red circle.

Fig 3 *T. morrisi* male, larva from Urunga, Bellinger River, pupated Sydney, emerged 7th Nov., 1922. Forewing Subapical ocellus surrounded by a faint cream circle, subterminal ocellus surrounded by a cream circle, sometimes indications of up to four pale spots between the ocelli, a subapical white bar between subapical ocellus and end of cell, a narrow white band below and on basal side of subterminal ocellus, extending from just below vein 1 to vein 4, usually larger and more extended in the female between veins 1 and 2, no bar across cell. Hindwing Both ocelli surrounded by bright orange-red circles, that surrounding the subterminal being very wide, an irregular white discal band basally to both ocelli.

The above descriptions of average male specimens, together with the coloured plate (Plate II. figs 1 and 3) will aid the description of the following family.

Fig 2 *T. joanna*, the female parent of figs 4-15, caught at Port Macquarie, 17th April, 1922, laid 14 eggs at Sydney, 18th and 19th April, killed 19th April, eggs hatched 2nd and 3rd May, 1922. As this female was brought home in a box from Port Macquarie and fed and kept alive to lay her eggs, the specimen is naturally rubbed and faded, but the figure gives a very good representation of the specimen as it now exists. Forewing Ocelli as in *morrisi*, though the subterminal is not so conspicuously ringed, subapical bar prominent, pale yellow; discal band pale orange, narrow, irregular, from veins 1 to 4, and extended between veins 1 and 2. Hindwing Ocelli ringed rather deeper orange-red than in *morrisi*, discal band much reduced in size and faintly indicated, pale orange. The figure apparently shows a pale orange bar across the cell of forewing, this is not present on the upper surface, but is due to the scales above being rubbed off, and the band from beneath showing through the wing.

Fig 5 Male, emerged 18th Nov., 1922. Forewing Ocelli as in *morrisi*, but surrounding circles fainter and browner, subapical bar yellowish cream; discal band broad, pale yellow, with traversing veins scaled brown, this band is very nearly as broad as in *abeona* and the portion across the cell is well defined. Hindwing as in *abeona*, no discal band, the circles surrounding the ocelli dull orange red.

Fig 8 Male, emerged 13th Nov, 1922 Almost identical with Fig 5, the pale band of forewing being slightly broader

Fig 11 Male, emerged 15th Nov, 1922 Forewing Ocelli as in *abeona*; subapical bar very faintly indicated, brown-orange, discal band broad, only extending slightly above vein 3, dull brown-orange, reduced to a suffusion within the cell Hindwing as in Figs 5 and 8

Fig 14 Male, emerged 20th Nov, 1922 Almost identical with Fig. 11

Fig 4 Female, emerged 1st Dec, 1922 Forewing Ocelli only faintly circled, subapical bar cream, broad, dull orange band confined between veins 1 and 3 Hindwing, as in *abeona*, no discal band, the circles surrounding the ocelli dull orange-red

Fig 7 Female, emerged 1st Dec, 1922 Forewing almost identical with Fig 4; the ocelli are surrounded by brown circles, the discal orange band is slightly brighter and broader, and extends across the cell Hindwing as in Fig 4, with the circles surrounding the ocelli slightly brighter

Fig 10 Male, emerged 17th Dec, 1922 Forewing Ocelli surrounded by brown circles, subapical orange bar faintly indicated, discal brown orange band confined between veins 1 and 3 and not entering cell Hindwing with discal orange band very faintly indicated basal to the ocelli, which are surrounded by dull brown orange circles Almost identical with Fig 14

Fig 12 Male, emerged 21st Dec, 1922 (pupated 3rd Dec) Forewing differs from Fig 10, in the subapical orange bar being more distinct, the discal brown orange band slightly narrower Hindwing differs from Fig 10 in having the discal orange band slightly better indicated

Fig 13. Female, emerged 22nd Jan, 1923 Forewing Ocelli surrounded with brown circles, subapical bar distinct, white, discal band broad bright orange, broad between veins 1 and 3, only entering cell as a suffusion Hindwing Circles surrounding ocelli orange-red; discal band yellowish, narrow, indistinct in the middle

Fig 6 Female, emerged 27th Jan, 1923 Forewing Ocelli surrounded with cream circles, subapical bar white, discal band broad white, extending as a well defined bar across cell Hindwing Ocelli very prominent, surrounded by dull orange-red circles, discal band very faintly indicated

Fig 9 Female, emerged 5th Febr, 1923 Only differs from Fig 7 in having a narrower discal orange band on the forewing, which is paler towards the costa.

Fig 15 Female, emerged 13th Febr, 1923 Forewing agrees with Figs 7 and 9, subapical bar narrower, discal orange band intermediate in width between those of Figs 7 and 9 Hindwing almost identical with Figs 7 and 9

When this family is studied it will be noticed that four males appeared before the first female, then another female, followed by two more males and finally four females; though the eggs were all laid within two days of one another and hatched within two days of one another, the difference in time of emergence of the first and last specimens was three months, whilst the difference in time between the first and last male was a little over one month, the difference between the first and last female was about two and a half months. It should also be noted that the sexes are equal in number. In general colour marking two males (figs. 5 and 8) and one female (fig 6) show the pale colour of the northern race *morrisi*, whilst the remainder have the darker colour marking of *abeona*, one specimen only (fig 13) has the hindwing band of *morrisi* at all well developed,

but much narrower and somewhat darker, a few specimens have this band slightly indicated. The colour of the circles surrounding the ocelli of the hindwing is intermediate between *morrisoni* and *abeona*, being much nearer the size and shade of the former. As regards the shape of the forewing marking, it should be remembered that *abeona* has a bar across the cell but this is absent in *morrisoni*, of the twelve offspring, six have this bar very well defined and include the three pale specimens, two (figs 11 and 13) have a suffused patch of orange scales, in figs 12 and 14 a few scales can be seen with a glass, but I cannot find any orange scales in the cells of the forewing in figs 4 and 10. Not one of the offspring shows any great resemblance to their mother, which represents a type seldom caught at Port Macquarie. This interesting family shows, in the general shape of its forewing markings and the absence of the hindwing band, a closer approximation to *abeona* than to *morrisoni*, and the colour of three-quarters of the specimens is that of *abeona* rather than *morrisoni*. In the size and colouration of the ocelli, the approximation is rather to *morrisoni* than to *abeona*.

The other family I reared under the same conditions, and which I also exhibit to-night, consisted of two males and three females, which emerged 16th Nov., 23rd Nov., 29th Nov., (male), 10th Dec., 1922, (male), 13th Febr., 1923. The female parent was also caught at Port Macquarie on 17th April, 1922, and laid a few eggs during 18th and 19th April, she was of the pale form, somewhat like Plate 1, fig 6 and was somewhat worn when caught and I have little doubt that most of her eggs had been laid before her capture, this is shown as well by the fact that her offspring consisted chiefly of females and that the first and second specimens to emerge were females. Three of the five specimens have white markings, two being orange, these two have a definite cell bar on the forewing, these bars are slightly indicated in the other specimens. All the specimens show traces of the discal band on the hindwing, this being most pronounced in the white female, well indicated in both the orange females, and showing only traces in the two white males. In this small family one male specimen approaches very close to Plate 1, fig 5, but has the hindwing band less well indicated, the two orange females, which both emerged in Nov., 1922, are intermediate between figs 3 and 11 on Plate 1. The other male is somewhat like Plate 1, fig 4, whilst the last female to emerge can be compared with Plate 1, fig 9, but has somewhat less white on the forewing.

The two families, consisting of 17 specimens, show 11 specimens with orange markings, a much bigger proportion than amongst the specimens we have caught at Port Macquarie and, owing to their comparative rarity there, we have always tried to secure every orange specimen we saw. The experiment would have been much more satisfactory if I had been able to secure both parents of my families, but under the circumstances I was not able to do so. I brought back several larvae from my trip of last year, but appropriate sexes did not emerge at suitable times to enable me to pair.

If evidence to show that *Disiphona joanna* is a hybrid race, were needed after the results of the experiments I brought forward last year, the two families that are now before you are quite conclusive evidence of that fact. Much more study has to be given to the butterflies obtained from these experiments, and the work has to be continued still further. I hope on some future occasion to lay before you the results of what I have done—results that are unique and novel as far as Australia is concerned.

Notes on the life-histories of Australian Butterflies

For some years I have been engaged in studying the life histories of our Australian Butterflies and have had excellent drawings made of their larvae and pupae. These have now increased so much that it seems desirable to furnish a list of those that are known, with a few notes as an aid to the possible discovery of the life-histories of other species not at present known. Very little so far has been published on the bionomics of our butterflies, but I hope, when my drawings and notes have increased a little more, to have the whole of the material at my disposal published as a companion volume to the "Butterflies of Australia." In 1864 we had the beginning of Scott's folios of "Australian Lepidoptera," where a few life-histories are given, in 1888 Mathew (Trans Ent Soc. London) described and figured a number of larvae and pupae from Australia, in 1889 Olliff added one or two more in "Australian Butterflies", in 1893 an excellent work, "Victorian Butterflies," by Anderson and Spry gave good accounts of the life-histories of a number of the Victorian species, in 1907 Rainbow published "A Guide to the Study of Australian Butterflies" incorporating what had been written before and adding some new life-histories, Illidge (Proc Royal Soc. Qld, 1900) has given a list of the Butterflies of the Brisbane district mentioning in many cases the foodplants of their larvae. A method I have often found successful in obtaining larvae, is to dissect the eggs from the body of a female, when usually one fertile egg is obtained. This method has been used in cases where I have been unable otherwise to find larvae, but is only useful where some knowledge of the probable foodplant can be obtained. The single larva of *Heteronympha solandri* that I succeeded in rearing through all its stages, was procured in this manner. In the following list I have used the generic name and subspecific name only.

Family *Nymphalidae*

Unless otherwise stated all pupae of this family hang suspended by the tail.

Subfamily *Danaeinae*.

The larvae of this subfamily feed upon plants which, when broken, exude a milky juice; they are smooth, with two or more pairs of long fleshy appendages. The pupae are short, smooth; often with brilliant metallic colours.

Danaida archippus and *D. petilia* both feed on the two cotton or milk weeds, the latter also on an indigenous native Asclepiadaceous plant in the interior.

Euploea corinna has been found feeding on Figs, Oleander, *Stephanotis* and *Mandevilla*. The other species of *Euploea* should be looked for on similar plants; some years ago I had a pupa of *E. darchia* from Port Darwin, but without note as to its foodplant.

Subfamily *Satyrinae*.

During the last few years I have been very successful in finding larvae of this subfamily and also in obtaining eggs from fertile females by a method pointed out to me by the late F. P. Spry. The larvae of the bulk of the species feed upon any of our soft grasses, indigenous or introduced. A female, placed in a cage of wire gauze or mosquito net over a pot of growing grass, will in most cases lay eggs, from which, with care, the larvae can be reared to pupae. Both the larvae and pupae of this subfamily are very variable as regards colour, and

little reliance can be placed on a description taken from one individual only; usually all the larval instars but the last are some shade of green, whilst the last instar may be green, brown or chocolate in the same species. Again green larvae may give either brown or green pupae; and similarly with brown larvae. In this subfamily the fullgrown larvae of some of the smaller species are hard to distinguish from young stages of the larger species. In all species that have come under my notice, the baby larva, on emerging from the egg, has a hard black head. The larvae are usually smooth or only slightly rough, head hard and often with lateral processes, they feed at dusk, or after dark. The pupae are usually smooth, never with spines, but sometimes possess dorsal ridges or corrugations.

Mycalesis infuscata—A single pupa only has been obtained by Mr N B Tindale.

Melanitis leda—I have only had green larvae of this, but the extraordinary head is variable in colour. It has been found feeding on *Paspalum*, *Buffalo* and other grasses.

Ypthima arctous—Foodplant grasses, all my larvae have been light brown in the last instar.

Hypocysta euphemia—Foodplant grasses, all larvae were brown in the last instar, in shape the pupa was allied to *H. metirius* and *H. pseudrius*.

H. metirius—Foodplant grasses, numerous larvae have all been green in all instars.

H. pseudrius—Foodplant grasses, larvae brown in last instar.

H. adiante—Foodplant grasses, larvae brown in last instar, pupa very long and thin and quite unlike the three other species of the genus.

Heteronympha—Six of the seven species have been obtained, they are all grass feeders and the colours of both larvae and pupae are very variable. I have had eggs of *H. cordaer*, but did not succeed in rearing any. Now that these life-histories are known a rearrangement of the order of the genus is necessary.

H. merope, *paradelpha* and *philelope* have the heads of the larvae without projecting horns, and pupate unattached on the ground under leaves, pieces of bark or logs.

H. mirifica *banki* and *solandri* have the heads of the larvae with prominent horns, and the pupae are attached by the tail, usually very close to the ground.

Argynnis hobartii—Foodplant grasses, passes most of the year as a pupa, pupating early in the year and the perfect insects emerging in September and October. Probably an occasional specimen emerges in March, which accounts for the records at that time, but it is not a general rule, for a dozen pupae I had remained in that state during the winter. The pupal skin is thick and tough and the pupa looks like a piece of charred wood.

Oreinemica lathomella—Foodplant grasses, I have had two larvae only which were very light brown in the last instar, but numerous green ones, pupa corrugated, attached by the tail.

O. corrae—Foodplant grasses, pupa corrugated, attached by tail.

Oreinemica latialis—I considered this as an alpine form of *O. lathomella*, but have since found that their ranges overlap slightly on Mt Kosciusko. Though the larvae are very similar, the pupae are very distinct, that of *latialis* being quite smooth and lying unattached on the ground, or amongst the tufts of snow grass on which the larvae feed. This form must now be raised to a distinct species.

O. orichora—Foodplant grasses, pupa smooth, unattached on ground.

Xenica acantha.—Foodplant grasses, larvae in most cases green in last instar, pupae attached by tail, brown or green. Young larvae are very difficult to separate from fully grown specimens of *Hypocysta metivius*

X klugi.—Foodplant grasses, larval head very hairy and without horns, green, pupa very difficult to separate from *acantha*.

Tisiphone abeona.—Foodplant sword grass (*Gahnia*); larvae always yellow green, a few showing a brown median dorsal band, pupae green, attached by tail

Subfamily *Nymphalinae*

Larvae spiny or with fleshy prominences bearing hairs (except *E sempronius*) Pupae angular, often grotesquely so, in *E sempronius* smooth, suspended by the tail.

Eulejns sempronius.—Foodplants several species of *Acacia*, including *A Baileyana*, *A longifolia*, also *Robinia pseudoacacia* Head of larva with four long horns Pupa smooth

Phaedryma shepherdis.—Foodplant flame tree on the Richmond River

Precis villida.—More often found on *Plantago*, feeds also on *Erythraea australis* and *Antirrhinum* (Snapdragon).

Pyramus kershawi.—Foodplants "Everlasting Daisies" and "Cape Weed"

P stea.—Foodplant nettles

Mynes guérini.—Foodplant "Stinging Tree" in the north

Hypolimnas nerina.—Foodplant "Sida" (Paddy's Lucerne)

Dolichocallis australis.—Foodplant a low growing scrub plant with a pale purple flower Pupa smooth

Cethosia chrysippe.—Feeds on a creeper I have a blown larva and several dead pupae from Mr F P Dodd

C paksha.—I have dead pupae only of this

Cynthia ada.—Known only to me from a pupal shell

Cupha prosope.—Known only to me from a pupal skin

Argynnis inconstans.—Mr. Ihedge tells me feeds on wild violets

Subfamily *Acraeinae*

Acraea andromacha.—Foodplant *Taxonia*, I have also taken eggs on various Passionfruits and Grenadilla Larva with branching spines, pupa smooth

Family *Lycaenidae*

The larvae are small, flattened and slug-like in shape and in most cases are attended by ants, and by watching ants one can often get a clue to where the larvae are hidden Young wattle bloom should be beaten into an umbrella in order to collect the larvae which are very difficult to find when feeding Any flowering vine should be searched and the buds opened, as larvae are often found in the unopened buds The young shoots that are given off from the stumps of some of our native trees are excellent places to search for larvae The pupae are usually fastened by the tail with a girdle round the middle and are found under pieces of bark on the trees, under leaves on the ground, in ants' nests, and in a few cases pupate under the soil

Phlaeis innotatus.—Foodplant the water Fig I have only a pupal shell which is of the usual Lycaenid type and very hairy

Caudalides xanthospilos.—Foodplant, species of *Pimelea* (2 species), larva green; pupa unusual in having a much flattened heart-shaped abdomen

C. heathii.—I have only found this on *Plantago*, though Mathew records it as feeding on *Westringia rosmarinifolia*, a coastal plant, around which I have often seen the butterflies flying.

C. abnormis.—Foodplant: *Castanospermum australe* (Black Bean or Moreton Bay Chestnut), I have recently taken it also on the native *Wistaria* and the young shoots of three trees.

C. hyacinthina.—Foodplant the parasitic *Cassythae*, a wire-like climber which often festoons other plants. Mr Dodd has found *C. erinus* on the same plant and no doubt *C. acasta* also feeds on it.

Pseudodipsas myrmecophila.—Both larvae and pupae have repeatedly been found in ants' nests and I have already suggested that the larvae are fed by the ants.

P. brisbanensis probably has the same habits, pupae having been obtained.

P. dyglesi.—Foodplant *Loranthus* (Mistletoe).

Miletus delicia.—Foodplants *Acacia decurrens* and *A. Cunninghamii* and probably other species.

M. apelles. Has been found feeding on a vine growing in the mangrove swamps.

M. hecalus.—Foodplant *Pomaderris*.

M. ignita.—Has been found feeding on several species of *Acacia*.

Thysanotis taygetus.—Foodplant a plant known as "Red Ash" (*Alphitonia excelsa*), both larvae and pupae are somewhat like those of *M. hecalus*.

Nacaduba felderi and *N. biocellata* I have found feeding on buds of several species of *Acacia*, and obtained the larvae by beating, they resemble the *Acacia* buds very closely. Mr Illidge has found larvae of *N. florinda* on *Trichia aspera* (Peach-leaf poison bush).

Syntarucus pseudocassius.—Foodplant *Plumbago*, feeds on the flowers.

Lampides damoetes.—Foodplants Dohchoes, sweet peas, lupins, Tree lucerne and many similar plants.

Catochrysops platessa.—Foodplant. *Crotalaria alata* (rattlepod). I found it once on a yellow flowered Leguminous vine near Cairns.

Zisina labradus.—Foodplant French Beans, lucerne, clover.

Neolucia agricola.—Foodplants. Flowers of *Dillwynia*, *Danaisia*, *Pultenaea*, *Bossiaea* and similar yellow spring flowering leguminous plants.

N. mathewi.—Foodplant. Flowers and young shoots of *Monotoca elliptica*.

N. serpentata.—Foodplant: *Atriplex semibaccatum*.

N. sulphurea.—Foodplant: *Rhagodia Billardieri* ("Saltbush") and other salt plants growing at the edges of mud flats in our estuaries.

Theclimnesthes onycha and *T. miskini*.—I have never satisfactorily separated these two species. Larvae have been found on *Acacia* and also *Macrosamnia*, I believe those on *Acacia* belong to *T. onycha* and the others to *T. miskini*.

T. scintillata.—Foodplant *Acacia* buds.

Paralucia aurifer and *P. pyrochus*.—Foodplant: *Bursaria* ("Blackthorn").

Pseudalmenus chlorinda.—Foodplants several species of *Acacia*.

Ogyris.—Foodplants. Several species of *Loranthus* (mistletoe).

All the species have been bred, excepting *O. idmo* and *O. otanoe*, but the various species of *Loranthus* have not yet been specifically determined.

Archopala.—I have had pupae of two species, but no record of the foodplant. Mr. F. P. Dodd informs me the larvae are attended by the green tree ant.

Protalmenus and *Ialmenus* have been found on several species of *Acacia* and do not seem to be confined to any one species.

Hypolycaena phorbos—The larvae are attended by the green tree ant. Mr. E. J. Dumigan has sent me larvae and pupae.

Lophyrus brassolus—Mr. F. P. Dodd, in his account of this wonderful species, believes the larvae feed on the larvae and pupae of the green tree ant.

Family Pieridae

Larva smooth or with scanty short hairs, pupae angulated, pointed at both ends, attached by the tail and a central girdle.

Delias—*D. nysa* and *D. nigridus* have not been bred, the others feed on *Loranthus* (mistletoe) and *D. aganippe*, in addition, on *Exocarpus* (Native Cherry).

Elodina angulipennis and *E. parthia*—Foodplant *Capparis*

Anaphaes teutonia—Foodplant *Capparis*

Huphina scyllara—Foodplant *Capparis*

Catopsilia—Foodplants Several species of *Cassia*

Terias sulphurata—Foodplant *Breynia oblongifolia*

T. smilar—One autumn a female laid four eggs on the young shoots of *Cassia fistula* growing in my garden. I reared three butterflies. There must be other foodplants, as *C. fistula* is not indigenous to southern New South Wales.

Family Papilionidae

Larvae very often with short fleshy spines, without hairs, pupae upright, attached by tail and a central girdle.

Troides—Larvae feed on *Aristolochia*, vines that grow in the scrub, two different species are known to me.

Papilio—All the species feed on plants giving a strong scent, when the leaves are crushed. In many cases they have taken to introduced ornamental trees, in preference to their own indigenous food plants.

P. sthenelus—Foodplant Citrus trees, *Salvia*

P. anactus—Foodplant Citrus trees

P. aegaeus—Foodplants Zizania ("wild lime"), Citrus trees

P. joesa—Foodplant *Erodia accedens*.

P. capaneus—Foodplant a rambling creeper, *Melodorum Leichhardtii*.

P. parmatius—Mr. E. J. Dumigan sent me a pupa which emerged and larvae which died during transit.

P. macleayanus—Foodplants Sassafras and Camphor Laurel

P. choredon—Foodplant Camphor Laurel

P. lycaon—Foodplant Custard Apple.

P. macfarlanei—I have had several pupae from Mr. F. P. Dodd which unfortunately emerged in the post.

Meneides queenslandicus—Foodplant *Aristolochia*

Eurytus cressida—Foodplant *Aristolochia* (several species)

Family Hesperidae.

Larvae smooth; head large and hard. Pupa elongate, enclosed within a shelter formed by drawing the foodplant together or within a curled leaf on the

ground Foodplants, in many cases, grasses or allied plants. I have successfully reared many species of Hesperidae and from the larval and pupal characters, I would place *Hesperilla* towards the end of the *Trapezitinae*, as their early stages are more allied to the *Erynninae*.

I have bred *Trapezites symmorus*, *T. elena* and *T. petala*, all found feeding on *Xerotes*.

Toxidia peroni, *T. doubledayi* and *T. parvula*.—Foodplant: grasses.

Dispar compacta.—Foodplant: grasses.

Signeta flammeata.—Foodplant: grasses

Mesodina halysia and *M. aeluropis*.—Foodplant: *Pattersonia*.

Motosingha dirphia.—Foodplant: *Lepidospermum*.

Oreisplanus perornatus.—Foodplant: *Gahnia* (sword grass).

O. munionga—I have found larvae at Mt. Kosciusko, feeding on a plant something like *Gahnia*.

Hesperilla.—All the larvae of this genus that are known feed on *Gahnia* (sword grass). These include *H. ornata*, *picta*, *cryptargyra*, *mastersi*, *idothesa*.

Taractrocera papyria.—Foodplant: grasses

Padraona lascivia.—Foodplant: *Imperata*

P. flavovittata and *P. hypomeloma*.—Foodplant: grasses

Cephrènes sperthias.—Foodplant: palms.

C. trichopepla.—Foodplant: palms

C. amalia.—Foodplant: millet.

Tehcota krefftii.—Foodplant: *Imperata*.

Badamia exclamations.—Foodplant: *Terminalia*.

Hasora haska.—Foodplant: native *Wistaria*.

Phaenocops beata.—Foodplants: *Tristania*, Camphor Laurel, Custard Apple.

Netrocoryne repanda.—Foodplants: *Callicoma*, *Endiandra*.

Euschemon rafflesia.—Foodplant: *Wilkiea macrophylla*

Though the foodplants of the Australian Butterflies are far from complete, a distinct advance has been made during the last ten years and I hope this imperfect list will be an aid to my colleagues, and also point out what remains to be done

Mr R. Illidge has placed his vast knowledge at my disposal, and the late Mr P. Spry supplied me with many notes. Mr. F. P. Dodd and Mr. E. J. Duminigan are responsible for many fine things from North Queensland. Whilst Messrs. A. N. Burns, G. M. Goldfinch, G. Lyell, J. Mann, V. J. Robinson, L. B. Thurn, S. T. Turner, S. J. Wilson, and G. H. Wyld are always searching for larvae and pupae to send me. Mr R. E. Turner's letters of some years back have provided many interesting notes.

In now vacating the post of honour to which you elected me two years ago, I must confess to a feeling of pride when I know that my name will stand amongst an honoured list of Past Presidents of this Society, many of whom are happily still with us. In presiding at our meetings, I felt at first some diffidence, as many of the men who sat around the table had been my early instructors and teachers. The unflinching courtesy of my colleagues on the Council has made my task much less burdensome than I had anticipated and I come to be your President with feelings that I have passed through two years of my life that will always carry the most pleasant of memories.

EXPLANATION OF PLATES 1-11.

Plate i.

Hybrids between *Tisiphona absconsa* and *T. morristi*

Fig. 1-6.—First generation Figs 1, 2, 4, 5 are males, Figs. 3, 6 females Figs 3, 4 and 5 are from the same family

Figs 7-12—Second generation Figs 7, 8, 10, 12 are males; Figs 9, 11 females All from the same first generation parents, Fig. 8 shows the male parent of all the third generation hybrids in these experiments

Figs. 13-15—Third generation. Figs 13 and 15 males, Fig. 14 a female

Plate ii.

Fig. 1.—*Tisiphona absconsa*, male, Sydney, emerged 4th Nov., 1922

Fig 2.—*T. joanna*, female, Port Macquarie, caught 17th April, 1922, laid eggs at Sydney, 18th and 19th April, 1922, which produced the originals of Figs. 4-15.

Fig. 3.—*T. morristi*, male, from larva found Urunga, Bellinger River, Oct., 1922, butterfly emerged, Sydney, 7th Nov., 1922

Fig 4.—*T. joanna*, female, emerged Sydney, 1st Dec., 1922

Fig 5.—*T. joanna*, male, emerged Sydney, 13th Nov., 1922

Fig. 6.—*T. joanna*, female, emerged Sydney, 27th Jan., 1923

Fig 7.—*T. joanna*, female, emerged Sydney, 1st Dec., 1922

Fig 8.—*T. joanna*, male, emerged Sydney, 13th Nov., 1922

Fig. 9.—*T. joanna*, female, emerged Sydney, 5th Feb., 1923

Fig. 10.—*T. joanna*, male, emerged Sydney, 17th Dec., 1922

Fig. 11.—*T. joanna*, male, emerged Sydney, 15th Nov., 1922

Fig. 12.—*T. joanna*, male, emerged Sydney, 21st Dec., 1922 (pupated 3rd Dec., 1922).

Fig 13.—*T. joanna*, female, emerged Sydney, 22nd Jan., 1923

Fig. 14.—*T. joanna*, male, emerged Sydney, 20th Nov., 1922

Fig. 15.—*T. joanna*, female, emerged Sydney, 13th Feb., 1923

Note.—An error occurred on page xi of my address last year, in line 7, for "forewing" read "hindwing" in the description of *T. absconsa aurelia*

Mr J H Campbell, Hon Treasurer, presented the balance sheets for the year 1922, duly signed by the Auditor, Mr F H Rayment, FCPA., Incorporated Accountant, and he moved that they be received and adopted, which was carried unanimously

No nominations of other Candidates having been received, the President declared the following elections for the ensuing Session to be duly made —

President: Mr A F Basset Hull

Members of Council (to fill six vacancies) Messrs E C Andrews, B A, FGS, J H Campbell, MBE, H. J Carter, B.A, FES, Sir T W. E David, KBE, CMG, DSO, DSc, FRS, Prof W A Haswell, DSc, FRS, Prof A A Lawson, DSc, FRSE

Auditor Mr F H Rayment, FCPA

A cordial vote of thanks to the retiring President was carried by acclama-

GENERAL ACCOUNT Balance Sheet at 31st December, 1921

INCOME ACCOUNT Year ended 31st December, 1922

Examined and found correct
F H RAYMENT, F.C.P.A.
 Auditor
 30th January, 1923

J H CAMPBELL,
Hon Treasurer
Sydney, 16th January 1923

LUNNEAN MACLEAY FELLOWSHIPS ACCOUNT
BALANCE SHEET at 31st December, 1922

LIABILITIES		ASSETS	
	£ s d		£ s d
Amount bequeathed by Sir William Macleay .	35,000 0 0	Commonwealth Loans	18,805 0 0
Surplus Income capitalised	9,000 0 0	N S Wales Inscribed Stock	1,815 0 0
Commercial Banking Coy of Sydney	16,500 0 0	Loans on Mortgage	40,080 0 0
	<u>£60,500 0 0</u>		<u>£60,500 0 0</u>

INCOME ACCOUNT Year ended 31st December, 1922

	£ s d		£ s d
To Salaries of Lunnean Macleay Fellows	1,600 0 0	By Interest on Investments .	2,524 17 6
" Fellows' Subsidies	118 7 0		
" General A/c	806 10 6		
	<u>£2,524 17 6</u>		<u>£2,524 17 6</u>

Examined and found correct Securities produced
30th January, 1923 F H RAYMENT, F C P A.,
Auditor

Sydney 16th January 1923 J H CAMPBELL
Hon Treasurer

EACHTERIOLOGY ACCOUNT

BALANCE SHEET at 31st December, 1922.

LIABILITIES		ASSETS	
Amount bequeathed by Sir Wm Macleay	£ s d	Commonwealth Loans	£ s d
Accumulated Income capitalised	12,000 0 0	Cash	73 13 0
Income A/c at 31st December, 1922	2,000 0 0	Savings Bank	100 0 0
	579 13 0	In hand	179 13 0
	<u>£14,579 13 0</u>		<u>£14,579 13 0</u>

INCOME ACCOUNT Year ended 31st December, 1922.

	£ s d		£ s d
To Salary and Wages	545 10 0	By Balance from 1921	446 9 3
" Gas	23 8 5	Interest on Investments	729 7 2
" Petty Cash	27 5 0		
" Balance to 1923	579 13 0		
	<u>£1,175 16 5</u>		<u>£1,175 16 5</u>

Examined and found correct
F H RAYMENT, F C P A
 Auditor
 30th January, 1923

J H CAMPBELL,
 Hon Treasurer
 Sydnev, 16th January 1923

THE HIGH TEMPERATURE ORGANISM OF FERMENTING TAN-BARK.

Part II

By R. GREG-SMITH, D.Sc., Macleay Bacteriologist to the Society

(Ten Text-figures)

[Read 28th March, 1923]

In the first part of this research, it was shown that tan-bark, after undergoing a preliminary treatment, known as "tempering," was capable of being attacked by a thermophilic bacterium and during the fermentation a quantity of carbon dioxide was given off. It was suggested that the preliminary treatment eliminated inhibiting substances such as the residual tannins of the bark.

On taking up the investigation again, the first problem that suggested itself was that of the nature of the fermentable constituents of the tempered bark. These are presumably soluble or slightly soluble in the liquid in contact with the bark and it seemed advisable to make an aqueous extract and test its fermentability.

Accordingly, 200 grams of tempered bark were warmed for 2 hours at 60° with 400 c.c. of water, and filtered through a Buchner funnel. The residue was again treated with water and this was repeated a third time. The total liquid and washings measured 1185 c.c. The fluid was evaporated under diminished pressure to 74 c.c. and filtered through a porcelain candle.

Ten c.c. portions, approximately equal to the extract from 27 grams of bark, were put into flasks, one of which contained kieselguhr and another contained filter paper; a third served as a control. A fourth flask contained 30 grams of the dried residual bark. All four flasks were put into the apparatus described in the first part of this paper. It will be remembered that the flasks were kept at 80° and a current of pure air swept any carbon dioxide evolved during fermentation into flasks of baryta water.

The flasks were seeded with bacteria at the start and were examined from time to time to determine the activity or vitality of the bacteria. Water was added as occasion demanded to replace that carried over in the current of air.

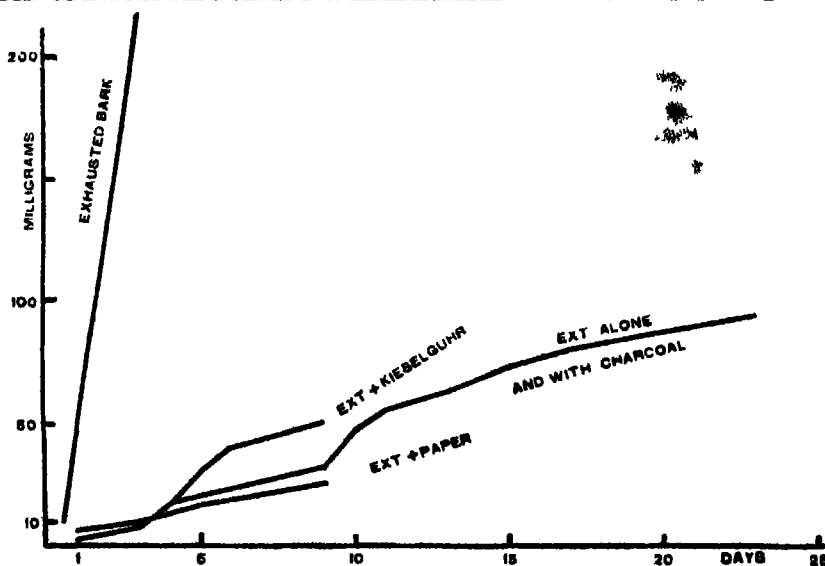
An early question that arose was, how much carbon dioxide would one be justified in assuming as having been derived from a fermentation and how much from the errors of the apparatus? The error of the apparatus is traceable to leakage of air containing carbon dioxide into the apparatus, possibly through defective connections, possibly by diffusion through thin-walled rubber tubing and possibly to escape past the guarding soda-lime and baryta water. Against

this leakage there may have been a loss through the fermentation carbon dioxide having been imperfectly caught in the measured baryta water. Doubtless there was a certain amount of compensation one way and the other but some cases in which there could be no uncertainty about the absence of fermentation gave a yield of about one milligram of carbon dioxide per diem.

In the tables that follow, the daily determinations which were made to the first decimal place are omitted and only the aggregate product to the nearest whole number is given. This makes for conciseness and gives the data from which the curves were constructed.

Table I --Carbon dioxide in milligrams
Aggregate amounts

	Days	1	2	3	4	5	6	9
1 Extract with kieselguhr	1	—	6	16	38	40	50	
2 Extract with paper	5	—	9	13	16	—	25	
3 Extract alone	2	—	7	1	20	—	30	
4 Water exhausted bark	45	186	217	282	336	372	—	



The extract had undoubtedly been fermented, for the aggregate amount of carbon dioxide is well above the limit fixed for the error of the apparatus. But the fermentation had been feeble and it is evident that water extracted but little fermentable matter from the bark. The amount of extract in each flask was derived from 27 grams of bark and the 30 grams of the residual, water-exhausted bark gave from 10 to 20 times the amount of carbon dioxide in five days.

The organic matter in the flasks was very small in amount. The liquid extract, evaporated and dried at 130°, contained 25% of solids and 52.8% of this consisted of ash. Thus the 10 c.c. in the fermenting flasks contained 120 milligrams of ash-free organic matter.

The test-tube reactions for the brown-coloured extract were those of humic

acid and doubtless this was the chief organic constituent. Naturally it would be present as humate.

At the close of the experiment, the flask with the extract alone (i.e., No 3) was kept and into it was placed a quantity of recently ignited willow charcoal. The idea was to see if the charcoal gave a better substratum for bacterial activity, something akin to moistened bark.

Table Ia —Carbon dioxide in mgrms
Willow charcoal added to No 3 on the ninth day

Days (continued)	10	11	13	15	17	19	23	26	30	33	36
Aggregate yield starting from 32	47	53	63	73	80	85	94	105	117	124	130

Before the addition of the charcoal, No 3 had given off 32 milligrams. Next day 15 mgrms. were obtained, no doubt chiefly derived from carbon dioxide adsorbed by the charcoal and given off at 60°. From the jump of the curve it would appear that 10 mgrms may be safely put down to this source and, making this allowance, it is shown that the charcoal aided the fermentation. We cannot go further and claim that the charcoal was itself fermented, for, although 130 milligrams of carbon dioxide were obtained from 120 mgrms* of humic acid plus charcoal in 36 days, yet the error of the apparatus, which we have put down at a milligram per diem, reduced the total to a quantity that might well be derived from the extract. It was, however, a trial experiment and as such is suggestive.

In a second experiment, 15 grams of tempered bark passing through a No 12 sieve but retained by No 24, were put into a Soxhlet oil-extraction apparatus and extracted with hot rectified spirit for 8 hours. On cooling, the alcohol threw out a fat which, on hydrolysis, yielded stearic acid (m.p. 70°).

The alcoholic extract was evaporated, transferred to a flask with water, seeded with bacteria, mixed with ignited pumice fragments and connected up in the fermentation apparatus.

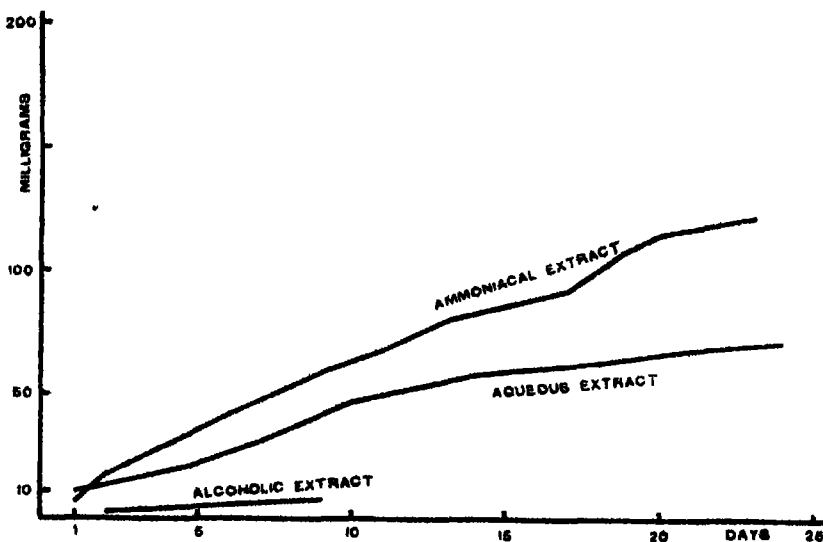
The bark, after the alcohol treatment, was extracted with hot water in the Soxhlet apparatus for 14 hours. The aqueous extract thus obtained was evaporated and worked up as in the previous paragraph.

The residual bark was percolated with 2% ammonia in the cold, then transferred to the Soxhlet apparatus and extracted hot for about 12 hours. The extract was evaporated to dryness, picked up with water and, being acid was neutralised with sodium hydrate and treated like the others.

Table II —Carbon dioxide in mgrms

Days	1	2	4	5	6	7	9	10	11	13	14	17	18	19	20	21	23	24
Alcoholic extract	—	2	—	—	—	—	7	—	—	—	—	—	—	—	—	—	—	—
Aqueous extract	10	12	—	23	—	31	—	47	—	58	—	68	—	—	—	68	—	71
Ammoniacal extract	6	17	20	—	42	—	59	—	68	80	—	92	—	108	115	—	122	—

* This quantity of humic acid with 64 % of carbon is theoretically capable of yielding 281 mgrms. of carbon dioxide.



The alcoholic extract gave only 7 mgrms. in 9 days and it is clearly evident that there was no fermentation. This is one of the examples that led to taking the error of the apparatus as one milligram per diem.

The curve of the ammoniacal extract is almost a straight line from the second to the thirteenth day. The sudden jump on the seventeenth day may have been caused by the addition of 0.05 grams of peptone to the flask, although a similar addition to the aqueous extract on the eighteenth day was without effect.

The aqueous and ammoniacal extracts undoubtedly contained some material that was fermented.

In determining the carbon dioxide caught in the baryta water by the difference in its alkalinity before and after exposure to the air coming from the flasks, it was necessary to allow for traces of ammonia, coming from some of the flasks, being caught in the cold baryta. At first this was done by neutralising the baryta, filtering off the barium carbonate, dissolving it in standard sulphuric acid, boiling to expel the carbon dioxide and determining the sulphuric acid neutralised. At a later date and especially when ammonium sulphate was used as a source of nitrogen in fermenting carbohydrates, it was found to be more convenient to distil off from 10 to 20 cc into a flask containing 1 cc of 0.1N sulphuric acid coloured with phenol-red. This gave an indication of the ammonia coming over and if the distillate remained yellow after 10 cc had passed over, the previously stopped inlet was connected with a soda-lime tube, the flask cooled down and the baryta titrated. When the distillate became alkaline, another cc of acid was added and the distillation was continued until it was certain that all the ammonia had passed over.

A third experiment was made with the tempered bark. Twenty grams were* digested for three days with 200 cc. of 1% hydrochloric acid to remove calcium and magnesium salts. The insoluble matter was washed until free from chlorine and the filtrate and washings (A) were evaporated to dryness, moistened with water and again evaporated. This was repeated several times and finally the suspension was made neutral to litmus. It was transferred to a flask and the

excess of water over 30 cc was removed by evaporation in a hot oven. The liquid was then seeded and the flask put in the fermentation apparatus. The contents of the flask had to be neutralised daily for they rapidly became acid to dyes such as brom-thymol blue. Only a small amount of carbon dioxide was given off—15.5 mgrms in 27 days—and thus was taken to represent the error of the apparatus.

The scheme of the experiment is tabulated in order to prevent confusion.

20 grams of tempered bark treated with dilute hydrochloric acid, filtered

Filtrate A	Residue treated with dilute ammonia, filtered			
	Filtrate B	Residue again treated with ammonia, filtered		
		Filtrate C	Residue separated into	
			Fine fragments D	Coarse fragments E

The residual bark after the acid treatment was digested in warm dilute ammonia (4%), allowed to stand overnight and filtered, it passed very slowly through the paper. Washing was continued until the filtrate became a pale brown. The filtrate and washings (B), after passage through porcelain, measured 1614 c.c. and this volume, less 10 c.c., contained 3.7 grams of dry matter, of which 0.3 gram was ash. The fluid was evaporated, transferred to a small flask, seeded with the organism and put into the fermentation apparatus.

In 1, 2, 4, 5, 6 and 7 days the aggregate yields of carbon dioxide were 10, 17, 32, 37, 43 and 48 mgrms.

As the fermentation appeared to be stopping on the 5th day, half a gram of peptone was added and, as this did not improve matters, the experiment was stopped on the 7th day.

The contents of the flask were mixed with the acid extract (A) when the dark-coloured liquid was converted into a gelatinous paste, probably the humates of calcium and magnesium. In the fermentation apparatus a considerable amount of carbon dioxide was given off at first, but the production quickly fell away.

In 1, 2, 4, 7, and 8 days the aggregate yields were 18, 21, 25, 36 and 38 mgrms. of carbon dioxide.

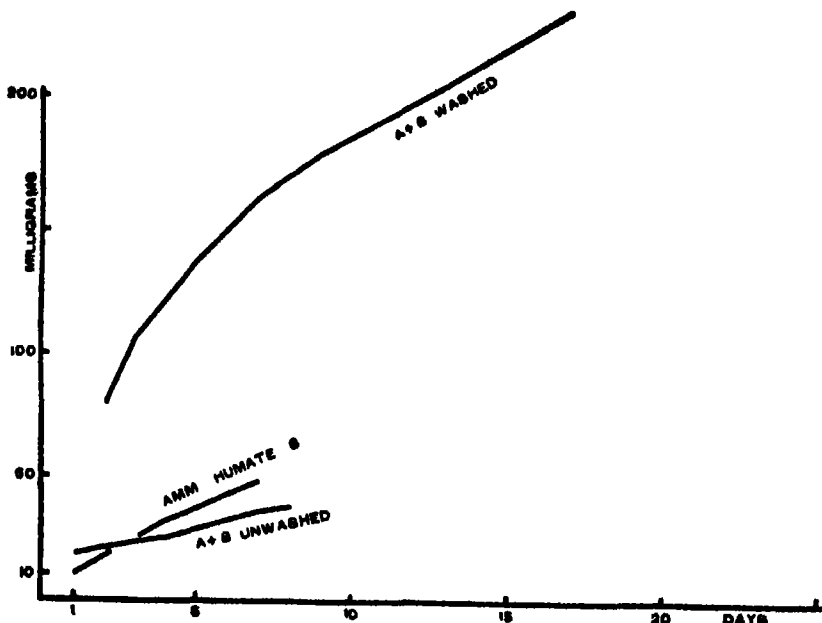
When tested on the seventh day, the pasty liquid was found to be sterile. In casting about for a reason for this state of affairs, it was remembered that the acid extract had been concentrated to a small volume and doubtless the salinity had become too great for the growth of the bacteria. The suspension was therefore filtered and washed with a solution of 0.5% magnesium sulphate, a salt which had, by this time, been found to be very useful for the growth of the bacillus. Thus the suspension was freed from any excess of saline matter and from peptone.

The insoluble matter dried at 60° for two days weighed 4.7 grams. It was ground in a mortar and put into a flask together with 30 cc ammonium sulphate solution* and seeded.

* Ammonium sulphate 5, magnesium sulphate, anhyd 1, sodium phosphate 2 potassium citrate 3 grams, brom-thymol blue solution 20 cc and tap-water to a litre.

Table III—Solid from Filtrates A + B
Carbon dioxide in mgrms

Days	2	8	5	7	9	11	13	16	18	24	28
Aggregate yield	79	106	138	163	181	195	209	230	240	262	276



The liquid was neutral on the second day, but had to be neutralised on the eleventh and twenty-first days. The bacteria were active throughout the experiment.

On plotting the yields, a curve is obtained and its logarithmic nature shows that the material had been fermented. A portion of the carbon dioxide would be derived from the citrate in the nutrient solution, but the yield is much in excess of the 73 milligrams theoretically capable of being derived from this source. Thus the insoluble matter obtained by adding the acid extract to the ammoniacal extract and consisting presumably of the humates of calcium and magnesium, is fermented by the organism.

The residue from Filtrate B was again treated with ammonia in much the same way as before and during the filtration, the insoluble particles were separated into heavier portions which remained in the beaker and lighter ones that were carried with the washing water on to the filter.

The filtrate, C, when evaporated and dried, gave 1.8 grams of residual matter which did not ferment. It became repeatedly acid during the attempted fermentation and, with the idea of preventing this, the acid was converted into a calcium salt by treatment with lime water. Even then there was no pronounced production of carbon dioxide—39 mgrms in nine days after allowing for included carbonate—and, as citrate of potash was unfortunately present in the nutritive fluid, no deduction could be drawn regarding the fermentability of the humate.

The smaller fragments of the residual bark (D) weighed 2.7 grams. They were put into a flask together with 30 c.c. of ammonium sulphate nutrient solution, neutralised, seeded and fermented.

Table iv —Small fragments (D)
Carbon dioxide in mgrms

Days	1	3	4	6	8	10	13	15	17
Aggregate yield	6	25	86	61	88	116	129	136	142

As the citrate added with the nutrient solution could not give more than 73 milligrams of carbon dioxide it is evident that the smaller fragments of residual bark were fermented.

The citrated nutrient solution had shown itself to be capable of producing a good growth of cells and certain control experiments had given no carbon dioxide. Later experiments, however, showed that citrate could be and was fermented. The possibility of its being fermented in these experiments must therefore be taken into account.

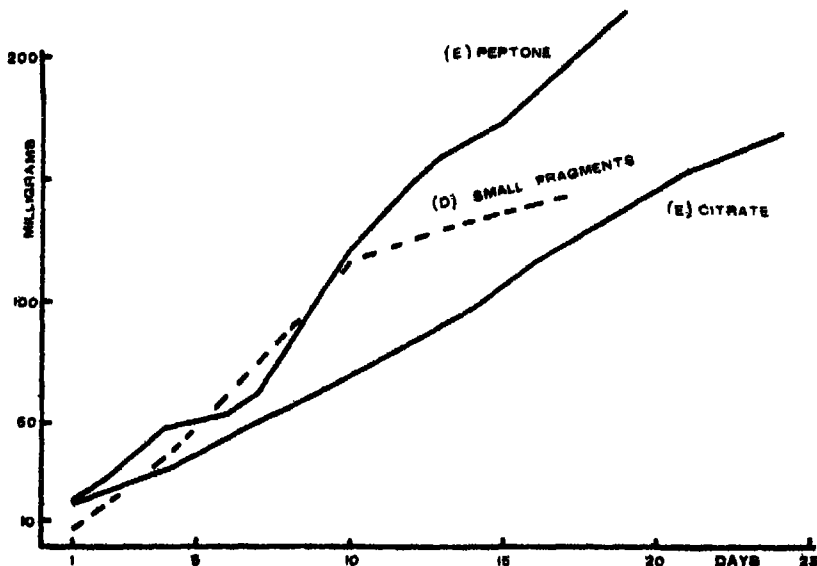
The coarse fragments of bark, E, after the second treatment with ammonia, weighed 6 grams and contained 14% of ash. A portion weighing 5.3 grams was put into a flask with 20 c.c. of water, seeded with the organism and adjusted in the fermentation apparatus. The fermentation began well but slowed down soon after the sixth day and half-a-gram of peptone was added in order to compensate for the loss of nitrogenous nutrients occasioned by the repeated extraction of the bark with water. Then fermentation proceeded much more quickly but, as it was shown soon afterwards that peptone itself is fermentable, the increased yield of carbon dioxide may have been due to the added peptone. Accordingly, on the nineteenth day, the solid contents of the flask were washed by decantation with water containing 0.5% of magnesium sulphate and the washed residue was put into a flask together with 20 c.c. of ammonium sulphate nutrient solution, seeded and connected up. Although the flask had no peptone, the 20 c.c. of nutrient solution which was added contained 0.06 gram of potassium citrate capable of yielding at most 49 milligrams of carbon dioxide and this should be allowed for in considering the fermentation.

Table iva —Coarse fragments of Bark (E) Carbon dioxide in mgrms Aggregate yield

Days	1	3	4	6	7	8	9	10	12	13	14	15	16	18	19	21	23	25	28
With peptone	18	27	48	54	62	81	102	121	148	159	—	173	—	—	218	—	—	—	—
With citrate	17	—	31	—	51	56	—	69	83	—	97	—	116	130	—	152	168	183	205

Considering the results from the bark with citrate and making an allowance for the carbon dioxide derivable from the citrate, it is evident that the coarse fragments of bark were fermented.

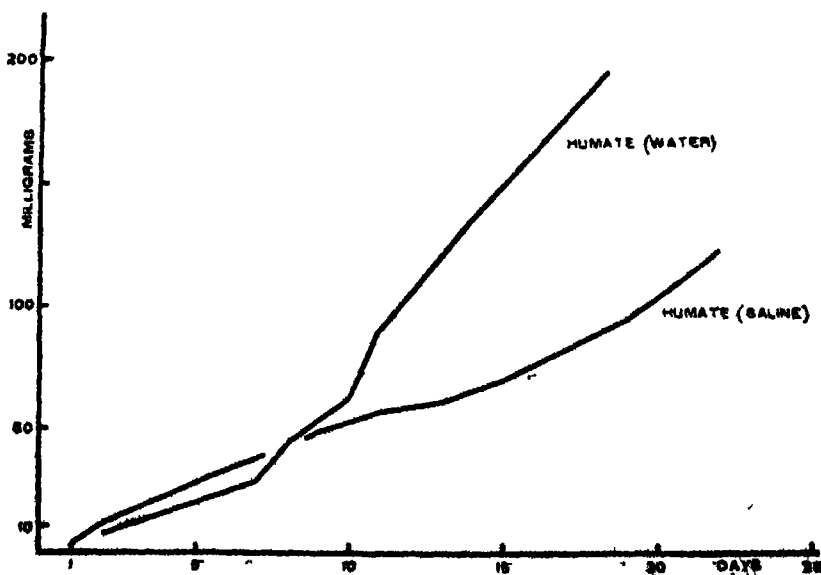
In a fourth experiment, a thirty gram portion of ground and sifted alley-bark was digested with dilute hydrochloric acid at 80° for a short time and next morning was filtered and washed. The residue, after digestion with 4% ammonium hydrate for two days, was filtered through paper. A quantity of the filtrate was treated with a proportional part of the acid filtrate and evaporated to dryness, then picked up with water and filtered. The dried residue weighed



35 grams It was placed in a distillation flask with 30 cc of a buffer mixture of inorganic salts and seeded after neutralisation with ammonia

Table v — Humate in saline Carbon dioxide in mgrms

Days	1	2	4	5	6	8	9	11	13	15	18	19	21	22
Aggregate yield	8	12	22	38	43	48	49	57	61	70	88	94	112	123



The reason for making this test was that the humate in the earlier test (Table III) contained fermentable citrate, and the evolution of carbon dioxide, 79 mgrms, by the second day seemed altogether too speedy for a true fermentation. It suggested an adsorption of carbon dioxide while the residue was drying in the incubator. Assuming that the 79 mgrms was adsorbed carbon dioxide and that the citrate yielded 70 mgrms by the 16th day, the difference of 80 mgrms is not very far from the results of the present test. And as this test contained no fermentable substance other than the humate, and the fermentation started slowly and appeared normal, there is no reason to doubt the fermentability of humate.

The speed of fermentation might have been faster had the buffer mixture of salts been less saline. It contained ammonium phosphate 0.5, potassium phosphate 0.5, anhydrous magnesium sulphate 0.1, sodium chloride 0.1 and calcium chloride 0.1 gram in 100 cc of tap-water. The solution acted well when testing the reaction, giving the full depth of colour in a dilution of 1 to 70. But it was too saline for giving a maximum fermentation. In proof of this we have the following data of the fermentation of 0.1 gram of lactose.

Days		1	4	5	7
Buffer solution	80 c c	2	8	12	22
Water	15 c c	}	7	27	40
Buffer solution	15 c c				

The half-strength buffer solution gave a better fermentation than did a Uchinsky solution containing ammonium sulphate in place of asparagin. The latter gave an aggregate of 15 in four and 31 mgrms in five days.

After finding that the buffer solution of salts was too strong, the supernatant fluid in the fermenting flask of the fourth experiment with humate was poured off and replaced by water. The following amounts were obtained.

Table VII—Humate in weak saline. Carbon dioxide in mgrms.

Days	2	7	8	9	10	11	14	18
Aggregate yield	7	29	44	53	62	90	135	189

Up to the eighteenth day, the yield was at the rate of 10.5 mgrms per diem as against 6 mgrms in the denser fluid.

In these experiments, the most pronounced fermentation was obtained from that humic acid which dissolved most easily in dilute ammonia. This did not occur, however, until the acid was combined with the bases of the bark previously extracted with dilute acid. The more difficultly soluble humic acid did not ferment to any extent but this may have been due to the absence of the natural bases. The organic matter insoluble in dilute ammonia was fermented, but not so actively as the humate.

The complete elimination of humic acid from the bark is not easy. In the last experiment (see above) the residual bark was divided and a portion subsequently found to be two-fifths (= 12 grams of original alley-bark) was treated with 4% ammonia. A deep-coloured extract was obtained. The residue was washed with dilute ammonia until the washings became of a port-wine colour. It was again treated overnight with 4% ammonia. This procedure was repeated.

two times more. The amounts of humic acid dissolved were 0.25, 0.19 and 0.14 grams by the third, fourth and fifth extractions respectively. It is evident that, for the complete elimination of the humic acid, an eighth or ninth extraction would have been necessary. Thus in Tables iv and iv_a, the fragments of exhausted bark would still contain humic acid and the carbon dioxide obtained by the fermentation of the fragments was probably derived from this residual humic acid.

It will be remembered that after the bark has fermented in the stack, it is subjected to a process of "tempering" during which it is watered and turned. The procedure palpably induces a mixed fermentation in which moulds play a part, for a white mouldy growth can be seen covering many of the outside lumps. From the results so far obtained, it is evident that "tempering" is a process of humification.

There is certainly more humic acid in tempering alley-bark than in tan-bark. As an example, a gram portion of dry tempered bark was treated with dilute hydrochloric acid and then with 50 cc of 4% ammonia for two days. The extract contained 0.46 gram of soluble matter. A control of dry tan-bark contained 0.32 gram.

The flora of the tempering heap comprises bacteria, yeasts and moulds and it is probably to the latter that the humification is mainly due. At any rate, among the moulds are several capable of fermenting cellulose and one would be justified in ascribing the degradation of the cellulose to these.

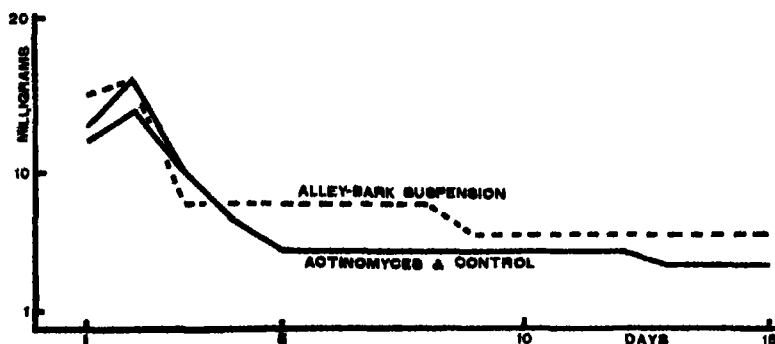
A fresh specimen of tempering bark was used in making suspensions or dilutions of various strengths. These were smeared on plates of Czapek agar and grown at 35°. On the second day the fourth plate contained 15 large colonies of which 7 consisted of a freely growing *Actinomyces*.

There were three and a half millions of these in a gram of the moist bark. Other small colonies developed later, but the *Actinomyces*, by its rapid growth, was clearly an important constituent of the flora. It grew on cellulose-agar, dissolving the cellulose and forming a clear halo around the margin of the growth or colony, showing that it secreted an enzyme capable of dissolving the cellulose in its vicinity. It seemed likely that this *Actinomyces* would play an important part in the decomposition or humification of the cellulose constituents of the bark.

To test the matter, three two-gram portions of sterilised tan-bark were moistened and seeded, one with the *Actinomyces*, another with a suspension of alley-bark organisms, while a third served as a control. After a month's incubation at 35°, the barks were allowed to dry, and a fortnight later were transferred to fermentation flasks, treated with 30 cc of ammonium phosphate saline, seeded with the high temperature organism and connected up in the thermostat at 60°. At the time of determining the carbon dioxide, the contents of the flasks had generally a H-ion concentration of from 6.8 to 6.5 when a dilute solution of ammonia was added to bring them down to 7.2.

Table vi.—Tan bark seeded with *Actinomyces* and suspension of Alley bark. Carbon dioxide in mgrms.

	Aggregate yields								Approximate daily yields														
Days	1	2	3	4	5	6	7	8	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Control	18	20	11	56	66	77	88	100	18	16	10	7	5	5	5	5	5	5	5	5	4	4	4
Actinomyces sp	12	26	48	54	63	72	81	93	12	14	10	7	5	5	5	5	5	5	5	5	4	4	4
Alley bark suspension	15	31	50	65	82	94	106	125	15	16	8	8	8	8	8	6	6	6	6	6	6	6	6



Upon plotting the numbers of the aggregate yields, drawing the curves and deducing from these the daily yields, it is seen that *Actinomyces* had no influence in preparing the way for the high temperature organism. The test behaved very much as the control, indeed, after the second day the yields were practically the same. It seems to have rendered inert some of the more easily fermentable matter and a similar behaviour will be seen later in the fermentation of cellulose (Table VII).

The bark that had been seeded with a suspension of organisms from alley-bark gave a greater amount of carbon dioxide than the control indicating that the mixed flora and fauna of tempered alley-bark contained an organism or mixture of organisms capable of altering the tan bark so that a better fermentation was obtained.

Other cellulose-dissolving moulds appeared upon plates of cellulose-ammonium sulphate-agar. They were vigorous growers and soon spread over the plates. One grew on potato, nutrient agar, salted paper, etc., as a white downy mass of interlacing aerial hyphae. These carried short septate conidiophores bearing a cluster of rather cylindrical spores measuring $2 \times 5\mu$. As a spore was formed at the pointed apex of the conidiophore, it was pushed off to make way for a younger cell and the spores were kept together by a fluid. Thus each conidiophore was terminated with a drop of liquid containing a number of spores. Microscopically, the aerial hyphae looked exactly like the block depicting *Hyalopus*, the "Wasserkugelpilz," in P. Landner's "Mikroskopische Betriebskontrolle in den Gärungsgewerben 2te Auf., p. 233.

On saline paper and all solid media, the mould grew as a white cotton-like vegetation, but here and there were small black specks. These proved to be aggregations of round black perithecia $100-120\mu$ in diameter which, when burst by the pressure on the slide, released rounded asci (19μ) containing eight lenticular, dark-coloured ascospores ($7.6 \times 11.4\mu$). Among the asci were spherical cells (14μ) with granular contents.

Another mould had a grey-green vegetation and grew easily on potato, agar of sorts, salted paper, tan-bark, etc. The aerial hyphae were arborescent in nature and each branch of the mycelial tree bore short septate conidiophores, terminated with a cluster of oval spores measuring $3 \times 5\mu$. The clusters did not carry a drop of water but the spores were kept together in little packets apparently by a film of some fluid. On plates of nutrient agar the mould grew as a fairy ring, which appearance was caused by the older conidiophores and aerial hyphae collapsing and the spores falling in a scattered heap on the agar.

floor. The mould slightly liquefied starch paste and produced some gas. It appeared to be a *Ghocladium*.

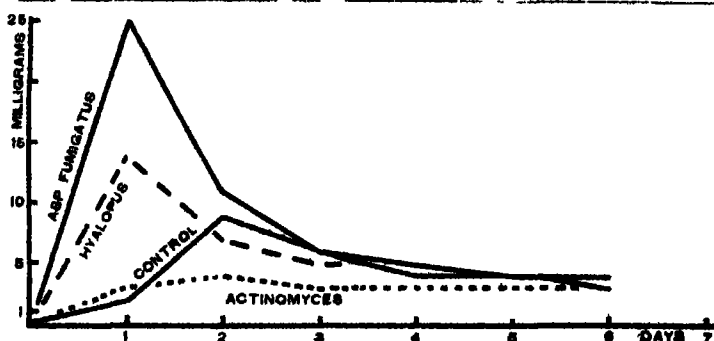
A third was a grey-green *Aspergillus* that grew freely on all ordinary media. The flask-shaped conidiophores measured 22 to 25 μ , the basidia were 7.5 μ long and the round smooth spores were 2.5 μ in diameter. Like the other moulds it grew freely at 35° and did not liquefy starch paste. These characters, together with the simple nature of the sterigmata, indicated that it was *Aspergillus fumigatus*.

These moulds during their growth dissolved the finely divided cellulose as contained in cellulose-agar and, as the alteration of the cellulosic portions of tan-bark is the reason for the preliminary treatment or tempering to which the bark is subjected, it was considered advisable to examine more closely their behaviour upon cellulose of a coarser texture.

Accordingly use was made of filter paper. This was cut up into small squares and two gram portions were put into flasks together with 5 cc of ammonium phosphate saline* and after steaming were seeded with the moulds. After a month at 35°, the contents of the flasks were transferred to distillation flasks, 30 cc of the same saline added to each, seeded with the high temperature bacterium and maintained at 60°.

Table vii.—Fermentation of Cellulose. Carbon dioxide in mgms.
Aggregate yields Approximate daily yields

Days	1	2	4	6	25	10	6	5	4	4
Control	3	10	20	27	1	2	3	4	5	6
<i>Actinomyces</i> sp.	3	5	13	20	2	9	6	4	4	7
<i>Hyalopus</i> sp.	17	21	30	39	3	4	3	3	3	3
<i>Ghocladium</i> sp.	25	36	47	54	14	7	5	5	4	4
<i>Asp. fumigatus</i>	25	35	50	54	25	11	6	5	4	3



The approximate daily yields give a clearer indication of the progress of the fermentation than the aggregate yields. They show that *Hyalopus*, *Ghocladium* and *Aspergillus* gave off a quantity of carbon dioxide during the first day when it was considered that the fermentation by the high temperature had scarcely had time to start. It would appear that the carbon dioxide was liberated by the moulds at a temperature of 60°, largely during the first day and slowly

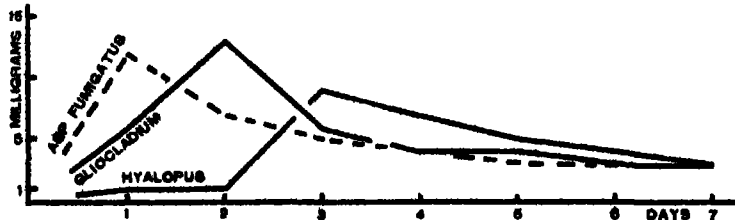
* Ammonium phosphate saline. Ammonium phosphate 0.3, potassium dihydrogen phosphate 0.1, magnesium sulphate (anhydrous) 0.05, sodium chloride 0.025, calcium chloride 0.025 grams in 100 cc of water containing 2 cc. of solution of brom-thymol blue.

during the next three The fermentation had its peak about the twelfth hour. In addition to this there is a fermentation of a constituent of the filter paper for the yields during the remaining days are greater than any error of the apparatus. The control indicates a fermentation with its peak on the second day, actually about the 36-hour period. From this the yield fell away very slowly in contrast with the rapid fall of the moulds. As the yields in the *Actinomyces* test were less than the control, we must assume that some of the fermentable material was rendered inert or destroyed.

Part of the experiment relating to the activity of *Hyalopus*, *Gliocladium* and *Aspergillus* was repeated. The moulds were grown on the paper for thirteen days at 35° as against a month in the previous case.

Table viii.—Fermentation of Cellulose Carbon dioxide in mgrms.

Days	Aggregate yields					Approximate daily yields						
	1	2	5	6	7	1	2	3	4	5	6	7
<i>Hyalopus</i> sp.	1	2	28	27	31	1	1	9	7	5	4	3
<i>Gliocladium</i> sp.	6	20	33	36	40	6	11	6	4	4	3	3
<i>Asp. fumigatus</i>	12	19	32	35	38	13	7	5	1	1	3	3



There are some differences in these results and it is possible that the shorter incubation of the moulds is responsible. *Aspergillus* had its peak on the first day, *Gliocladium* on the second and *Hyalopus* on the third day. As each received the same amount of bacterial suspension it would seem that the shorter incubation gave products of variable fermentability.

The action of the high temperature organism upon the paper attacked by the moulds called for some elucidation, especially in the rapid evolution of carbon dioxide during the first few days and the long continued but slow later fermentation. It seemed possible that the keeping of the paper in the moist sterile condition might either induce the absorption of some atmospheric carbon dioxide or might so alter the paper that it could be easily attacked by the high temperature organism. The mould in such a case might have little influence in preparing the paper for attack by the bacillus.

Some experiments were made to determine these points. In the first, water and paper and also ammonium phosphate-saline and paper were kept for 24 days at 35° when they were transferred to the fermentation apparatus.

The water and paper gave 3 mgrms. of carbon dioxide in three days and no more by the sixth day, water alone gave 2 mgrms. by the third and no more. The saline and paper gave 4.5 mgrms. by the ninth day and the saline alone gave the same. Thus about half a milligram was given off daily and thus probably represents the error of the apparatus. We may therefore conclude that there is no actual fixation or absorption of carbon dioxide by paper or by nutrient fluids during nearly a month's storage in the incubator at 35°.

On the ninth day the saline and the saline plus paper were seeded with the high temperature organism.

Table VIII —The Fermentation of Cellulose by the *Bacillus* Carbon dioxide in mgrms

Days	Aggregate yields									Approximate daily yields									
	Sterile		Seeded							Sterile		Seeded							
	3	6	9	10	11	13	14	15	17	20	9	10	11	12	13	14	15	16	17
Saline and paper	2	3	5	6	14	21	24	26	30	35	0	5	1	5	8	0	4	5	3
Saline alone	2	3	5	6	—	—	—	—	7	—	—	—	—	—	—	—	—	—	—

Following the addition of the high temperature organism to the paper a quantity of carbon dioxide was given off, the yield rose to a maximum on the 11th day, two days after the seeding. It then fell away slowly until the 17th day when the yield was 15 mgrms at which it remained until the 20th day when the experiment was stopped.

This experiment is instructive in showing that paper can be fermented by the high temperature organism. The control yielded 7 mgrms in 15 days and the paper yielded 26 mgrms, the difference of 19 mgrms of carbon dioxide resulted from the fermentation of the paper. It was not very much, but still it was a fermentation and it showed that the carbon dioxide produced from the fermentation of paper after "tempering" by moulds was in part due to the fermentation of the cellulose directly.

In order to see if carbon dioxide was given off when the growth of mould upon paper was subjected to a temperature of 60° in a current of air for some days, an experiment similar to VII and VIII was started. After growing at 35° for 16 days, the cultures along with the paper and fluid were transferred to distillation (fermentation) flasks and maintained at 60°. When tested on the third day for the high temperature bacillus, the fluids in the flasks containing *Aspergillus* and *Hyalopus* were found to be infected. The experiment, therefore, so far as they were concerned, became a duplication of VII and VIII. Two odd tests of *Aspergillus* and *Hyalopus* which were also found to be infected are included in the table.

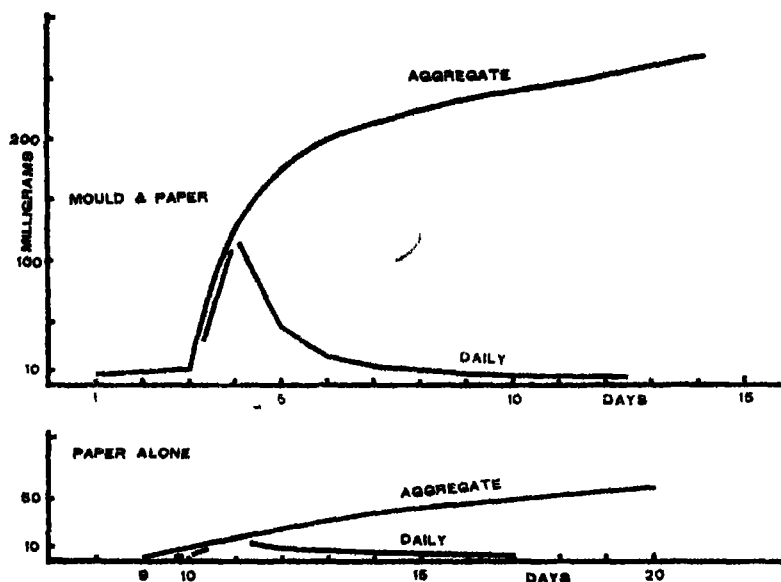
Table VIII —Fermentation of Cellulose after attack by Moulds Carbon dioxide in mgrms

Days	1	2	3	4
<i>Hyalopus</i> sp., 16 days	1	3	14	24
<i>Hyalopus</i> sp., 14 days	7	—	39	50
<i>Asp. fumigatus</i> , 16 days	5	18	25	30
<i>Asp. fumigatus</i> , 9 days	2	10	17	—
Controls without paper	—	—	—	2

A culture of *Gliocladium* on two grams of filter paper in 30 cc of ammonium phosphate saline, after 10 days at 35° was transferred to a fermentation flask and maintained at 60°. When transferred, the fluid in contact with the paper had an acidity of pH 4.4 and both it and the control were brought to pH 7.0. On the third day when the calculated daily yield had fallen to zero and the flask had been found to be free from the high temperature bacillus, a culture of the organism was added to each flask.

Table IX —The Fermentation of Cellulose after attack by *Gliocladium* Carbon dioxide in mgrms

		Aggregate yields										Approximate daily yields														
Days		Seeded with bacillus																								
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	1	2	3	4	5	6	7	8	9	10	11
Gliocladium, saline and paper		4	6	66	89	107	113	117	123	134						8	4	5	6	7	8	9	10	11		
Gliocladium and saline		0	3	2	4	—	—	—	6	—						0	60	23	11	7	6	4	2	3		



In the fermentation of the paper previously attacked or "tempered" by *Ghocladium*, we have an example of a comparatively rapid fermentation which shows that the substances formed by the mould from the paper are of an easily fermentable nature. This was exhibited by the jump from zero to 60 mgrms during the 24 hours following the introduction of the bacillus. The important point of the experiment is that the mould attacks cellulose and forms substances which do not liberate carbon dioxide on warming and which are attacked by the high temperature organism. The nature of these substances is at present unknown and although the liquid in contact with the mould became acid, there was not enough organic acid formed, as was shown by later tests, to ascribe the fermentation to the mould. Moulds are known to attack cellulose producing cellobiose and it was doubtless this sugar that was fermented.

A further experiment on the same lines was made, the moulds being grown in contact with the paper for nine days at 35°. After two days in the fermentation apparatus at 60° they were tested for the presence of the high temperature organism and then seeded with it. The *Asp fumigatus* test was found to be contaminated and has been included in Table viib. The other mould cultures were sterile so far as the bacillus was concerned.

Table ixa.—The Fermentation of Cellulose after attack by Moulds
Carbon dioxide in mgrms

Days	Aggregate yields						Approximate daily yields						
			Seeded with bacillus						Seeded				
<i>Actinomyces</i> sp	1	2	3	4	5	7	7	2	3	4	5	6	7
<i>Hyalopus</i> sp	1	1	8	12	15	19	1	0	7	4	3	2	2
<i>Ghocladium</i> sp	2	2	22	21	29	47	2	0	8	5	3	2	1
	3	3	10	14	16	21	3	0	19	11	7	4	3

These bear out and confirm the previous test made with *Ghocladium* showing that the moulds attack the cellulose and the products are fermentable by the high temperature organism. During the attack by the moulds the paper became

pulpy and, microscopically, many single fibres were seen to have been split up into numerous strands

The fermentable substances appear to be dissolved in the fluid in contact with the paper, for 30 c.c. of the fluid of a seven day's bulk culture, when seeded with the bacillus, gave 13, 7 and 3 mgrms. of carbon dioxide in 1, 2 and 4 days respectively. It behaved like the cultures in the Tables ix and x.

In the tempering heap where a revivification of the spent bark takes place, it is evident to the eye that moulds probably take an active part in the process. The characteristic fermentable substance of tempered bark is humic acid and extracts containing this were shown to be attacked by the high temperature organism. There is more humate in tempered bark than in tan-bark and the tempering may be said to be a humification.

Several moulds were isolated from the bark and these attacked filter paper, giving rise to substances which were fermented by the thermophilic bacillus to carbon dioxide.

My thanks are due to Mr W. W. L'Estrange for much kindly assistance in the work.

STUDIES IN AUSTRALIAN ENTOMOLOGY

No XVIII NEW GENERA AND SPECIES OF CARABIDAE

(Scaritini, Pterostichini, Merizodini, Bembidiini, Trechini, Odacanthini, Panagaeini, Licinini, and Lebiini.)

By THOMAS G SLOANE

(Continued from Vol xl, 1915, p 473 *)

[Read 28th March, 1923]

Tribe Scaritini.

Genus DYSCHIRIUS

Table of Australian Species

- | | | | | |
|--------|---|------------------|---|--|
| 1 (2) | Colour uniformly black | Length, 2.5 mm | . | } <i>mastersi</i> MacI
<i>stephensi</i> MacI |
| 2 (1) | Colour not wholly black | | | |
| 3 (4) | Elytra reddish testaceous with a broad central black fascia | Length, 3.5 mm | . | } <i>sonatus</i> |
| 4 (3) | Elytra never with a central black fascia | | | |
| 5 (8) | Size major | Length, 4 mm | | |
| 6 (7) | Head and pronotum (except peduncle) ferruginous red | | | |
| 7 (6) | Head (except clypeus) and pronotum black | | . | } <i>torrensensis</i> Blackb
<i>macleayi</i> Sl |
| 8 (5) | Size minor | | | |
| 9 (10) | Black, elytra with two sanguineous maculae behind middle, striae not extending behind transverse basal depression | Length, 2.23 mm | | |
| 10 (9) | Prothorax piceous black, elytra ferruginous brown, striae extending backwards to ante-apical maculae | Length, 2.5-3 mm | | } <i>ovensensis</i> Blackb
<i>wilsoni</i> Sl |
| | | | | |

In arranging this table I have not had before me *D. stephensi* MacI, *D. sonatus* Putz., and *D. torrensensis* Blackb, but have relied on the descriptions of these species for the differences mentioned

DYSCHIRIUS WILSONI, n sp

Elongate-oval, convex Piceous, head and pronotum black; elytra ferruginous brown with a transverse reddish macula on each elytron above apical declivity; under surface of a dull reddish colour, antennae infusate with basal joint livid; legs reddish, apex of femora, base of tibiae, and tarsi infusate

Vertex smooth, convex, front defined posteriorly by a transverse straight ridge turned obliquely backward near each eye, a fine longitudinal median ridge, a transverse sulcus (on each side of median ridge before the posterior ridge), and a juxta-ocular sulcus on each side; clypeus declivous, emarginate, lateral

*There is no number xlii in this series, so that No xiv follows No xii

angles slightly prominent, supra-antennal plates large, convex. Prothorax globose, pedunculate, laevigate, nitid, basal channel defining peduncle. Elytra truncate-oval, very convex, lightly transversely impressed at basal third, punctate-striate on basal half (before maculae), striae shorter on sides than on disc, interstices a little convex before transverse impressions, 3, 5, and 7 seriatly setigero-punctate, lateral channel narrow, punctate, wider and with larger punctures near base, border narrow, forming a minute denticule at humeral angle. Anterior tibiae with apical digitation long, narrow, pointed, two outer teeth small, dentiform. Transverse suture of metasternum marked by a row of six large punctures. Length, 2.5–3 mm, breadth, 0.9–1.05 mm.

Hab—Victoria. Beauconsfield, near Melbourne. Several specimens were taken by Mr. F. E. Wilson in tussocks of grass.—Colls. Wilson and Sloane.

Closely allied to *D. stephensi* MacL, and *D. ovensensis* Blackb., which it resembles in form of head and prothorax. From *D. stephensi* and *D. mastersi* MacL it differs by colour not wholly black, the prothorax is proportionally wider and more rounded on sides than in *D. stephensi*. From *D. ovensensis* it differs by colour, elytra with striae reaching back to the maculae. In *D. ovensensis* the inner striae are shorter than the outer ones. It is at once differentiated from *D. torrensensis* Blackb., and *D. macleayi* Sl. by its smaller size.

Genus CLIVINA

CLIVINA SULCATIONEPS, n. sp.

Narrow, cylindrical. Head narrow (1.3 mm across eyes), depressed, longitudinally trisulcate on each side of vertex, clypeus widely and decidedly emarginate, not divided from the rounded lateral parts, mandibles long, prominent, decussate, labrum 5-setose, prothorax longer than broad, evidently narrowed to apex, elytra parallel, striate, stria 4 joining 5 at base, interstice 8 carinate at base, not raised at apex, peduncle with lateral cavities punctate, prosternum with intercoxal part wide, pro-episterna transversely rugulose and punctate, anterior tibiae 4-dentate, lower side with a strong transverse ridge beneath second external tooth. Castaneous, head and prothorax darker than elytra.

Head elongate, impunctate, nitid, clypeus smooth, strongly divided from front in middle, raised into a transverse ridge between frontal impressions, lateral parts depressed, not defined from median part or supra-antennal plates, rounded and decidedly more prominent than median part. Eyes small, round, lightly convex. Prothorax narrow (2 x 1.7 mm), widest near posterior angles, lightly narrowed to apex (1.5 mm), convex, disc laevigate, subrugulose on sides, anterior margin lightly emarginate in middle, anterior border strongly developed, anterior angles near head, narrow, prominent, posterior angles rounded, median and anterior lines strongly impressed. Elytra cylindrical (4.5 x 2 mm), deeply striate, striae crenulate. Length, 8.8, breadth, 2 mm.

Hab—Northern Territory. Alligator River. Type in National Museum, Melbourne.

It has seemed better not to formulate a new genus for this aberrant species, but to leave it in *Clivina*, where it will form the type of a new group. The form of the anterior tibiae, with their transverse ridge on lower side, has not been seen by me elsewhere in the genus *Clivina*, but occurs in the South American genus

Oxytomus, while the striated head recalls that of *Schisogenus*. The form of the maxillary palps and mentum resembles those of *Chivina planiceps* Putz, but the mentum has not the longitudinal ridges of the lobes as in that species.

Genus LACCOSCAPHUS

LACCOSCAPHUS CYANEUS Fabr., var. AENESCENS, n. var.

Differs from the typical form of *L. cyaneus* Fabr., by having the upper surface of a coppery bronze colour. Length, 10.5–12 mm.

Hab.—Queensland. Herberton District (Dodd). Colls. Sloane (type) and British Museum (cotype).

Note.—*L. cyaneus* varies considerably in size, specimens in my possession measure from 10.5 to 14 mm in length. It ranges from Cairns at least as far north as Cooktown, and extends inland at least to Chillagoe.

Genus TERATIDIUM

TERATIDIUM PARALLELUM, n. sp.

Elongate, cylindrical. Head convex, subquadrate, constricted posteriorly, posterior part of frontal impressions obsolescent. Nitid, black, elytra virescent with purple reflections, prothorax with slight viridescent and purple reflections towards base and sides.

Head large (4.5 mm across eyes), two supra-orbital punctures on each side, front with a foveiform impression at each end of clypeal suture, occiput depressed below plane of vertex, clypeus strongly declivous, median part roundly emarginate, labrum emarginate, eyes deeply set in and not more prominent than orbits, orbits large, projecting strongly and almost rectangularly from sides of head, almost parallel on outer side, enclosing posterior two-thirds of eyes. Prothorax longer than broad (5.2 x 4.5 mm), lightly angustate to base, sides parallel, lightly angustate just before base, anterior margin truncate, angles lightly and obtusely advanced, base areolate, angles obtuse, border narrow, thicker and more raised on base, marginal channel narrow, bearing 2 or 3 punctures on anterior half and 2 punctures at beginning of basal curve on each side. Elytra laevigate, a shade wider than prothorax (10 x 4.6 mm.), a little depressed on disc, parallel, base emarginate, steeply declivous, lateral border thick and convex posteriorly, narrow upturned and rounded at humeral angles; a wide oblique punctate post-basal impression on each side. Ventral segments unipunctate on each side. Legs light, anterior tibiae with apex prominent, slender, a small dentiform prominence on outer side at base of apical digitation, posterior coxae and trochanters impunctate. Length, 20, breadth, 4.6 mm.

Hab.—Northern Territory. Adelaide River. Type in British Museum.

It belongs to the section of the genus in which the front is without strong sulci between the eyes. It is nearly allied to *T. convexum* Sl., the chief differences being the viridescent colour of the elytra, clypeus semicircularly emarginate behind the labrum (which is also roundly emarginate), orbits standing out more abruptly from head; prothorax with anterior angles more obtuse; elytra more parallel and more obtuse at apex; anterior tibiae wider, and with the small external denticule more developed.

Tribe Pterostichini.

PHERSITA CRENULATA, n.sp

♀ Elliptical, rather depressed. Prothorax subquadrate, wider at base (1.85 mm) than apex (1.4 mm), elytra ovate, crenulate-striate, interstice 1 with a short stria at base, 3 unipunctate beside stria 3 at middle, 8 carinate towards apex, basal border dentate at shoulders. Piceous red.

Head convex, rather narrow (1.3 across eyes), front lightly and shortly bi-impressed, median space lightly convex, eyes (including orbits) reniform, small, convex but not prominent. Prothorax broader than long (1.7 x 2.1 mm), widest before middle, sides lightly arcuate on anterior half, very lightly narrowed posteriorly, straight before base, apex lightly emarginate, angles obtuse, bordered, base wide, truncate, bordered, angles rectangular, basal area depressed, rather densely but finely punctate, the puncturation stronger in basal impressions, these wide, shallow, flat, lateral border narrow, reflexed, a narrow subcostate space dividing basal impressions from marginal channel. Elytra truncate-oval (4 x 2.8 mm), lightly and widely convex, interstices depressed on disc, 7 convex; stria 7 fully developed. Ventral segments 4-6 with a row of closely set fine punctures along anterior margin, 6 plurisetose at apex. Length, 7.2, breadth, 2.8 mm.

Hab—N.S. Wales. Mount Kosciusko. I found a single specimen near the Hotel Kosciusko (5,000 feet) on 6th December.

A distinct species. From *Ph. melbournensis* Cast., it differs by head narrower, eyes not nearly so prominent, prothorax longer, less rounded on arcuate part of sides, more lightly narrowed to base in a longer and more gentle slope, basal area more depressed and more punctate, basal impressions shallower and flatter, elytra proportionately longer, less convex, striae finer and shallower on disc, etc. From *Ph. tasmanica* Sl., it can be distinguished, *inter alia*, by prothorax less rounded on sides, basal area larger, more depressed and punctate.

Genus *PROSOPOGMUS**PROSOPOGMUS OPACIDERMIS*, n.sp

Elliptical, subdepressed. Prothorax angustate and sinuate posteriorly, wider at base (2 mm) than apex (1.7 mm), basal angles rectangular with apex blunted, elytra fully but not deeply striate, interstices (including 8) depressed, 5-7 narrower and lightly convex at apex, 3 tripunctate, 8 free at apex, metepisterna longer than broad. Black, head and prothorax nitid, elytra subnitid in ♂, subopaque in ♀, legs black, tibiae piceous, antennae, palpi and tarsi piceous red.

Head not large (1.65 mm across eyes), convex; frontal impressions well marked, eyes reniform, rather prominent. Prothorax broader than long (♂, 2 x 2.3 mm), lightly sinuately narrowed to base, sides lightly arcuate anteriorly; anterior angles obtuse, subprominent, bordered, base truncate, inner basal impression striolate, rather long, outer impression striolate, feeble, interspace flat; lateral border narrow, ending at basal angle, a seta beside basal angle inside border. Elytra oval (5 x 3 mm); basal border a little raised above lateral border and feebly dentate at humeral angle; anterior puncture of interstice 3 beside stria 3, two posterior punctures beside stria 2, interstices 5 and 7 enclosing 6 at apex, 7-9 nearly equal in width. Prosternum bordered at base of intercoxal part.

♀. More robust than ♂; prothorax wider (2 x 2.5 mm.); elytra duller in colour.

Length, 8.5—9.5; breadth, 3—3.5 mm.

Hab—NS Wales Eccleston (J Hopson)

This species can only be confused with *P. monochrous* Chaud., which it closely resembles in size and appearance, but it differs by prothorax narrower at base and more sinuate on sides, elytra less nitid in both sexes (especially ♀), interstices less convex in both sexes, depressed on disc in ♀, shagreened in both sexes (so strongly so as to be opaque in ♀), third interstice 3-punctate.

Note—*P. opacidermis* is the only species of the genus in which I have been any variation in the number of punctures on the third interstice of the elytra, eight specimens are before me, of these, six have the third interstice normally 3-punctate, as described above, one of the remaining two specimens (♀) has the left elytron normally punctate, but only the middle puncture present on the right, the other has the two anterior punctures present on the left elytron, but only the middle puncture on the right.

PROSOPOGMUS INTERSTITIALIS, n. sp.

Parallel, elliptical. Prothorax subquadrate, wider at base (2 mm.) than apex (1.6 mm.), strongly bi-impressed on each side of base, basal angles almost rectangular; elytra strongly striate, interstices convex, 3 tri-punctate, 8 free at apex, met-episterna elongate. Black, nitid; femora piceous, tibiae, tarsi and antennae piceous brown.

Head moderate (1.5 mm. across eyes), convex, frontal impressions well marked, short, extending across clypeus, divergent backward, eyes prominent, lightly enclosed behind, post-ocular parts of orbits small, but projecting sharply from head. Prothorax broader than long (1.8 x 2.2 mm.), widest a little before middle, depressed on disc, sides lightly curved, oblique near base, anterior angles narrow, obtuse, rather prominent, base lightly emarginate in middle, angles sub-rectangular with apex blunted, inner basal impressions subfoveiform, outer impressions foveate, deep, sometimes a few punctures in basal impressions; a seta just within basal angle. Elytra truncate-oval (4.2 x 2.75 mm.); humeral angles strongly marked, dentate, interstices convex, 1—4 more convex in ♂ than ♀, 3 with anterior puncture beside stria 3 and the two posterior ones beside stria 2, 6—8 enclosing 7 at apex, 7—9 subequal in width, a short stria at base of interstice 2. Prosternum bordered at base. Length, 7.2—7.5, breadth, 2.75 mm.

Hab.—NS Wales Mount Wilson (Carter), Eccleston.

Closely allied to *P. oodiformis* MacI., from which it differs by elytra nitid (not shagreened), black (not olivaceous), prothorax proportionately narrower, especially towards base, basal impressions deeper; elytra more deeply striate, interstices convex, etc. Formerly I confused this species with *P. occidentalis* MacI., but that species is smaller, and has the basal foveae of the prothorax more punctate. In some lights a slight sub-violaceous flush may be noticed on the elytra, especially in ♂. I believe *P. interstitialis* extends from the Blue Mountains into Queensland, perhaps as far as the tropics.

Genus TRICHOSTERNUS

TRICHOSTERNUS PERATER, n.sp.

Elongate-oval Head bisetose on each side above eye, tooth of mentum rounded, penultimate joint of labial palpi with two median setae and a setule at inner side of apex, prothorax transversely subcordate, lateral margins bisetose, posterior seta a little before basal angle, elytra oval, costate, humeral angles prominent, prosternum plurisetose between coxae, intercoxal declivity concave, mesosternum glabrous between coxae Black

Head large (8.5 across eyes), swollen below eyes, genae arcuate-truncate outside base of mandibles, outer angle obtuse but marked, frontal impressions wide, shallow Prothorax broader than long (7.75 x 10.3 mm), nitid, surface with faint transverse striolae, sides arcuate on anterior two-thirds, lightly sinuate posteriorly and meeting base at right angles, apex truncate, angles obtuse, not prominent, base emarginate in middle, lightly arcuate on each side, basal angles rectangular, sub-prominent and obtuse at summit, lateral border thick, wide near anterior angles, median and anterior transverse lines lightly impressed, lateral basal impressions wide, foveiform, connected by a well-defined transverse impression Elytra oval (26 x 13 mm), lightly convex, lightly and evenly rounded at sides, subopaque, finely shagreened, striae feebly punctate, odd interspaces strongly raised (7 strongest), nitid at summits, even ones subconvex, opaque, 3 quadri-punctate on posterior two-thirds, 8 not indicated at apex, 9 a little raised, seriate-punctate; basal border decidedly but obtusely raised at humeral angles Metasternum not punctate at sides Abdomen in ♂ 2-, in ♀ 4-setose at apex Posterior coxae contiguous ♂, anterior tarsi lightly dilated, weakly squamose beneath three basal joints Length, 36-38.5, breadth, 12-13 mm

Hab.—N.S. Wales Tweed River (Carter and Sloane) Coll Sloane

This fine species was first given to me by Mr H. J. Carter who had taken it on the Tweed River, afterwards I got a single specimen in the brush near Murwillumbah In size it equals *T. renardi* Chaud., which it resembles so closely that at a casual glance it seems to be conspecific, but an examination shows that it differs greatly by intercoxal declivity of mesosternum glabrous, external angles of genae far more marked (in *T. renardi* the outer side of the genae is similar in its curvature to the lobes of the mentum, in *T. perater* the outer side is squarer and more truncate at apex), prothorax more ampliate anteriorly, anterior angles more widely margined and therefore more distant from neck, transverse impression connecting lateral basal impressions deeper, elytra with eighth interspace not developed at apex, ninth less clearly defined from lateral channel, puncture at base of first interspace wanting, prosternum not longitudinally channelled, but with a wide foveiform impression between coxae, metasternum not punctate at sides; posterior femora narrower, less roundly inflated on lower side, ♂ three basal joints of anterior tarsi far less strongly dilatate, and less squamose beneath

TRICHOSTERNUS SIMPLICIPES, n.sp.

Elongate-oval, subdepressed Head lightly bi-impressed, bisetose on each side above eyes, tooth of mentum rounded at apex, penultimate joint of labial palpi bisetose, prothorax truncate-cordate, lateral margins bisetose, posterior seta near basal angle, elytra oval, interspaces 1-7 costate, 8, 5 and 7 more raised than others, humeral angles strongly and obtusely dentate, intercoxal parts of

prosternum and mesosternum setose; ♂. anterior tarsi naked beneath. Black, prothorax viridescent on sides, elytra with ninth interstice and lateral channel cupreous.

Head large (5 mm across eyes); frontal impressions wide, shallow, orbits shortly swollen behind eyes, genae projecting widely from base of mandibles, subparallel at sides, arcuate at apex. Prothorax broader than long (4.3 x 6.3 mm.), widest just behind anterior marginal seta; sides lightly rounded anteriorly, lightly sinuate posteriorly, meeting base at right angles, apex lightly emarginate, angles obtusely rounded, hardly advanced, base emarginate and fringed above peduncle, truncate on each side, not bordered, angles subrectangular, lateral border reflexed, lateral channel narrow, median line lightly impressed, lateral basal impressions elongate, shallow, spaces between these impressions and border flat. Elytra oval (12 x 8 mm.), truncate at base, lightly declivous to sides and apex, striae punctulate, interstices 3 and 5 strongly costate, 7 carinate, 2, 4 and 6 highly costate, 8 bi-setose on apical half, 9 nitid, narrow, punctate, developed towards apex. Metasternum with one or two punctures near each posterior angle. Abdomen in ♂ 2-, in ♀ 4-setose at apex. Posterior coxae contiguous. Length, 22-24; breadth, 7.4-8.5 mm.

Hab—Queensland Bunya Mountain (H J Carter). Four specimens have been examined, given to me by Mr H J Carter, who found this species not uncommon at the Bunya Mountain, South Queensland, in October.

Allied to *T. subvirens* Chaud., with which it agrees in the form of tooth of mentum, and in secondary sexual characters, but differing by form narrower, head black, prothorax less metallic, elytra black (excepting margin, cupreous), interstices of disc more unequal, the even ones being less costate than the odd ones.

TRICHOSTERNUS SETOSIOMPS, n sp

♀. Elongate-oval. Head strongly bi-impressed, 4-setose on each side above eye, tooth of mentum excised at apex, penultimate joint of labial palpi 3-setose on inner side and with two distal setules, prothorax subcordate, disc opaque and transversely striolate, lateral margins bisetose, posterior seta considerably before base; elytra 3-carinate, humeral angles hardly prominent, intercoxal part of prosternum 6-setose, of mesosternum glabrous. Black.

Head large (5.3 mm across eyes), sides lightly tumid behind eyes, genae projecting widely from base of mandibles, subparallel at sides, roundly truncate at apex, prothorax broader than long (4.5 x 6.4 mm.), widest at anterior marginal seta; sides rounded on anterior two-thirds, sinuate posteriorly and meeting base at right angles, apex lightly emarginate, anterior angles obtuse, a little advanced, base narrowly bordered, lightly truncate-emarginate and with a hair-fringe above peduncle, truncate on each side, basal angles rectangular, obtuse at summit, lateral border nitid, its course interrupted by anterior setiferous puncture, lateral channel wide, finely granulate, opaque, median and anterior transverse impressions strongly marked, lateral basal impressions strongly impressed. Elytra opaque, oval (12 x 8 mm.), a little narrowed to base, lightly convex, strongly declivous at sides, striae distinct, punctate, interstices 3, 5 and 7 carinate (summits nitid), 2, 4, 6 and 8 depressed but a little convex posteriorly, 9 merged with margin; lateral margin wide, nitid; basal border strong, connecting bases of interstices 7 and lateral border with a little nodule at humeral angle. Posterior coxae contiguous. Abdomen 8-setose at apex. Length, 20.5-23; breadth, 6.6-8 mm.

Hab—Queensland South Johnstone River (H. W. Brown); Malanda (G. F. Hill). Two specimens (♀) are before me, one is in my collection, the other belongs to Mr G. F. Hill.

It resembles *T. marginatus* Chaud., in appearance, but is quite distinct from it, and from all other described species, by head with four supra-orbital setae on each side, prothorax opaque and transversely striolate as in *Loxogenius opacipennis* MacL. Its position in the genus is beside *T. cyanescinctus* Boisd., and *T. superbus* Cast.

NOTONOMUS DEHISCENS, n. sp.

Oval, depressed. Head stout; prothorax cordate-quadrate, sinuate on sides, basal angles subrectangular, posterior marginal seta in lateral channel at basal angle, elytra complanate, fully striate, interstices lightly convex in ♂, depressed in ♀, 3 with three or four punctures, humeral angles rounded. Black (rarely with a virescent flush on prothorax and elytra), antennae piceous, legs, basal joint of antennae, and mouth parts piceous red.

Head large (4 mm across eyes), frontal impressions light but distinct, eyes convex. Prothorax broader than long (4.3 x 5.4 mm), depressed, as wide at base as at apex (4.1 mm), sides rounded, obliquely narrowed posteriorly, lightly sinuate just before base, anterior angles obtuse, base truncate, angles rectangular, obtuse at summit, lateral border narrow, lateral basal impressions parallel, deep, rather elongate and wide. Elytra truncate-oval (11.2 x 7), dehiscent at apex, lateral apical sinuities well developed, wide, basal border considerably raised, but joining lateral border at humeral angles without interruption, interstice 10 rather elongate, depressed. Intercostal declivity of prosternum rounded in middle, of mesosternum concave. Apical ventrite in ♂ with one, in ♀ with two punctures on each side. Length, 18–20, breadth, 6–7.2 mm.

Hab.—Victoria. Mounts Hotham and Feathertop. I found it plentifully under logs on the road to Grant (between the sources of the Dargo and Wonnangatta Rivers) at 4,700 feet, and on the slope of Mt Feathertop (5,000 feet) in February.

Very closely allied to *N. muelleri* Sl., from which it differs chiefly by sides of prothorax sinuate posteriorly, ♂ with apical ventrite unipunctate on each side.* It resembles *N. peroni* Cast., so closely that in my note on *N. peroni* (These Proceedings, 1913, 421), when I knew only the ♀, I took it for a form of that species and recorded it as "*N. peroni*, var. D. Black." Now that the ♂ is known it is seen that in addition to its black colour it differs from *N. peroni* by ♂ with joints 1–3 of the anterior tarsi dilate and squamose beneath.

* *N. muelleri* has sometimes a faint greenish tinge on the prothorax and elytra. Of seven male specimens which I have examined, five had at each side of the apex of the abdomen two setigerous punctures near together, and two had two setae on one side, but only one on the other. Only two out of nineteen male specimens of *N. dehiscens* examined, were found to have two setigerous punctures on one side of apex of the abdomen, all the others having one seta on each side. Collecting between Mts Kosciuszko and Hotham may produce intermediate forms showing *N. muelleri* and *N. dehiscens* to be forms of one species, but, even then, I believe a name for each form will be convenient.

NOTONOMUS HOPSONI, n. sp.

Elongate-oval, convex. Head stout; prothorax cordate, posterior angles not marked, posterior marginal seta distant from base, elytra oval, deeply striate, interstices convex, 3 quadripunctate, 8 narrow, lateral apical sinuosities deep, in ♂ roundly curved, in ♀ semicircular, inflexed margin truncated by apical sinuosities (widely truncated in ♀). Black, elytra varying from an obscure bronze colour to bright-cupreous, often dull purple in ♂.

Head rather large, convex (3.5 mm across eyes). Prothorax broader than long (4 x 4.4 mm), widest before middle, narrower at base (3.8 mm) than apex (3.8 mm), sides rounded, obliquely narrowed to base, sometimes subsinuate near base, basal angles obtuse, lateral border narrow, lateral basal impressions shallow, wide. Elytra oval (10.3 x 6 mm), convex, humeral angles rounded; basal border well developed, not dentate, but a little raised above lateral border at shoulders. Intercoxal declivity of prosternum rounded, of mesosternum very lightly concave. Length, 18–22, breadth, 5.1–5.4 mm.

Hab—NS Wales. Eccleston. I found this species generally on the Allyn River below the level of 2,600 feet in March, 1921. It is the species I have erroneously recorded as *N. johnstoni* (These Proceedings, 1916, 1917) from the lower brushes of the Williams River.

This species belongs to the *N. exosipennis*-group, but differs from the other two members of that group by having the lateral apical sinuosities of the elytra more strongly excused. Comparing the ♀ (no specimen of *N. johnstoni* ♂ is available), the differences of the apical sinuosities readily distinguish it from *N. johnstoni*, in *N. johnstoni* these sinuosities sharply abbreviate the inflexed margin, and are strongly excused, but their backward course is a gentle curve, in which the internal plica is seen as a narrow process; in *N. hopsoni* the inflexed margin is wider at apex, so that it is more decidedly abbreviated, and, owing to the strong outward dilatation of the inner plica, the lateral sinuosity is deeper and forms a more or less semi-circular notch. The apical sinuosity in ♂ is almost as in *N. johnstoni* ♀, but the margin of the elytra round the sinuosity is more curved. The raised process of the apical ventral segment which fits into the apical sinuosity is considerably more developed in *N. hopsoni* than in *N. johnstoni*.

NOTONOMUS ELLIPTICUS, n. sp.

♀. Elongate. Head rather large (3.3 mm across eyes), prothorax subquadrate, depressed, posterior marginal puncture on inner side of marginal channel near basal angle, elytra deeply striate, interstices convex, 3 bi-punctate, 8 narrow. Nitid, upper surface (including head) cupreous, under surface and legs black; tarsi and antennae reddish-piceous.

Eyes convex, prominent; frontal impressions deep, short, divergent backwards. Prothorax broader than long (4.2 x 4.55 mm.), lightly rounded on sides, wider across base (3.5 mm) than apex (3.3 mm.), base emarginate in middle, basal angles marked, obtuse at summit, border strongly reflexed, subsinuate just before base, extending along, base on each side to lateral basal impressions, these impressions narrow, deep; median line strongly impressed. Elytra oval (10 x 5.5 mm.), depressed on disc, apical curve strongly sinuate on each side, basal border strongly raised and prominent at humeral angles; striae deep, simple; interstices convex, narrow and carinate near apex, 8 narrow, wider than 9 on basal half, 9

very narrow, 10 well developed, extending forward from apical sinuosities half way to base. Intercoxal declivity of prosternum flat, of mesosternum lightly concave. Length, 18, breadth, 5.5 mm.

Hab—Queensland. Two specimens (♀) in British Museum ticketed "Queensland, Challenger Exp." are the types of this species. I have seen a specimen from Booyong, Richmond River, N.S. Wales.

It belongs to the *N. opacicollis*-group of the genus, being allied to *N. wilsoni* Cast., from which it differs by colour more metallic (including head), size larger, frontal impressions of head deeper, prothorax less narrowed to base, elytral interstices more convex, particularly on apical declivity.

NOTONOMUS CURVICOLLIS, n.sp.

♂ Elongate-oval, convex. Head stout, prothorax transverse, strongly and evenly rounded at sides, posterior marginal seta on border at basal angles, elytra oval, fully and strongly striate, interstice 3 quadri-punctate on posterior two-thirds. Joint 1 of intermediate tarsi 2-spinulose, of posterior 1-spinulose beneath costa of outer side. Elytra virent, prothorax viridaceous, head aeneous on front and vertex, under surface and legs black, apex of tibiae, tarsi, and antennae somewhat reddish.

Head convex (3.5 mm across eyes), eyes roundly convex. Prothorax broader than long (4.4 x 5 mm), convex, apex and base of equal width (3.35 mm), sides evenly arcuate, basal angles roundly obtuse, lateral border wide, reflexed, lateral basal impressions short, oval, deep. Elytra oval (11 x 6.2 mm), convex, ante-apical sinuosities shallow, oval, interstices hardly convex, 8 wider than 9 on basal half, 10 well developed, not long. Intercoxal declivity of prosternum rounded and narrow in middle, of mesosternum widely concave. Length, 18.5, breadth, 6.2 mm.

Hab—Victoria. Unique in Coll. Sloane. I found it in February on the steep side of Mount Feathertop under felled timber at 5,700 feet.

Allied to *N. rainbowi* Sl., *N. banksi* Sl., and *N. aequalis* Sl. It is at once distinguished from *N. rainbowi* by smaller size and green colour. From *N. banksi* it differs by smaller size, prothorax shorter and more strongly rounded on sides. It is about the same size as *N. aequalis*, but differs by prothorax more strongly rounded at sides, interstices of elytra less convex, particularly towards apex, etc.

Tribe Merisodini

Genus PTEROCYRTUS

PTEROCYRTUS TRUNCATICOLLIS, n.sp.

Stout, elongate-oval. Head stout; prothorax subquadrate, basal angles rectangular, elytra oval, punctate-striate, basal border well developed. Black, border of prothorax and elytra dull red, antennae, mouth parts, and legs reddish; femora reddish piceous.

Head convex (0.9 mm. across eyes), frontal impressions short, wide, clypeus with a foveiform puncture on each side; eyes round, convex, but not prominent, distant from buccal fissure beneath, 2 supra-orbital setae on each side. Prothorax subquadrate (1 x 1.35 mm), broadest before middle, wider across base than apex, sides lightly rounded anteriorly, lightly oblique posteriorly, anterior

angles obtuse, a little advanced, base wide, truncate, basal angles rectangular but obtuse at summit, border narrow, not extending on to base, lateral basal impressions deep, wide, short, punctulate; space between basal impressions and lateral channel narrow, convex, posterior marginal seta at basal angle. Elytra oval (2.5 x 1.8 mm), convex, fully striate, striae punctate, discal interstices a little convex, 1 with a short basal stria, 3 tri-punctate, 8 carinate posteriorly. Length, 4.3, breadth, 1.8 mm.

Hab—Victoria. I obtained three specimens in a dry situation, under moss on a rock, beside the road from St Bernard Hospice to Grant in the mountains at the source of the Dargo and Wonnangatta Rivers, at 5,000 feet.

I have referred this species to the genus *Pterocyrtus* with doubt, it is the first species from the mainland to be put in this genus, with which it agrees in all characters, except that the head has two supra-orbital setae on each side, the elytra have the basal border strongly developed and reaching to the first interstice, raised but not dentate at humeral angles, there is a short scutellar stria at base of first interstice. It will form the type of a distinct section in the genus. Its narrow subquadrate prothorax and punctate-striate elytra give it quite a different facies from *Brachydema tasmaniae* Sl.

Tribe Bembidiini

Genus TACHYS

TACHYS SYDNEYENSIS, n sp

Oval, convex, laevigate. Two minute setiferous punctures on disc of each elytron. Piceous, legs dull testaceous, antennae infuscate, basal joint testaceous.

Head wide, convex, frontal impressions wide apart, shallow, short, parallel. Prothorax transverse, truncate-cordate; sides rounded anteriorly, subannate before base, basal angles subrectangular, obtuse at summit, base wide, transversely impressed in middle near edge, lateral basal impressions obsolete, border very narrow, extending on to base on each side. Elytra oval, convex, laevigate, apical striae very short and feebly impressed, three marginal punctures behind shoulders and three on apical curve. Length, 1.4, breadth, 0.6 mm.

Hab—N S Wales. Sydney. Type in Coll. Sloane.

This species was obtained by me in December on the edge of a small pool among the sandy hills near Manly. Two specimens from the Castelnau collection in the Museum of Genoa were sent to me by Dr. Netolitzky, to whom they were returned under the name of "*T. sydneyensis* (cotypes)".

Its nearest allies are *T. australicus* Sl., and *T. captus* Blackb. (also *Tachyta horda* Bates—unknown to me in nature), from all of these it differs in the complete absence of striae on the elytra, and from *T. captus* and *T. horda* by its convex form; in this it resembles *T. australicus*, but differs by the want of the sutural stria, in *T. australicus*, too, the prothorax has the basal angles more acute, and the lateral channel narrower beside these angles.

Tribe Trechini.

Genus TRECHUS

TRECHUS KOSCIUSKOANUS, n sp

Oval, rather depressed. Prothorax transverse, much wider across base than apex, base truncate, basal angles rectangular; elytra finely striate, apical striae

distinct; interstices 3 tri-punctate, two small discal punctures beside stria 3, posterior puncture on apical declivity, basal border extending inwards to base of interstices 3. Black, nitid, femora piceous, tibiae and tarsi ferruginous; antennae piceous, basal joint ferruginous, palpi piceous.

Head large (1 mm across eyes), frontal sulci curved, strongly impressed but not deep, eyes convex, but not prominent, post-ocular part of orbits small, projecting a little from head. Prothorax broad (1 x 1.3 mm.), anterior angles wide, rounded, sides lightly arcuate anteriorly, hardly narrowed to base, lateral border narrow, lateral basal foveae wide, deep. Elytra broad (2.5 x 1.8 mm.), rather depressed on disc, a little declivous to base, humeral angles marked, and with border strongly raised, base wide, four inner striae distinct, 5—7 faint but perceptible. Length, 3.8—4.5, breadth, 1.65—1.8 mm.

Hab - N S Wales Mount Kosciusko. Several specimens collected by me on 7th December under stones beside the track to the summit at from 6,800 to 7,300 feet.

A distinct species more allied to *T. robustus* Sl, than to any other, but, comparing it with the description of that species, its smaller size and shining black colour are in themselves sufficient to distinguish it. From *T. diemenensis* Bates it is differentiated by colour, prothorax more transverse, much wider across base, more arcuate on sides, lateral border narrower and less upturned near base, elytra with striae finer, apical striae not hooked, punctures of third interstices smaller, the anterior puncture beside third stria not interrupting the interstices.

TRICHUS AUSTRALIENSIS, n sp.

Elliptical-oval, depressed. Prothorax transversely truncate-cordate, basal angles rectangular, elytra finely striate, apical striae distinct, interstices 3 tri-punctate, two small discal punctures beside stria 3, posterior puncture on apical declivity, basal border extending inward to stria 4. Reddish brown, head and prothorax more reddish than elytra, interstices 1 of elytra usually reddish, legs and antennae ferruginous.

Head large (0.7 mm across eyes), frontal impressions curved, deep, defining post-ocular part of orbits, eyes convex, but not prominent; post-ocular part of orbits protuberant. Prothorax broader than long (0.65 x 0.85 mm.); base truncate, a little narrower than apex, lateral border rather wide; lateral basal impressions narrow, rather deep. Elytra oval (1.7 x 1.3 mm.), depressed, a little declivous to base, humeral angles rounded, border narrow, three inner striae distinct, 5 and 6 faint. Length, 2.8—3.2, breadth, 1.2—1.3 mm.

Hab - N S Wales Mount Kosciusko. I collected it on 7th December not uncommonly under stones beside the track to the summit at from 6,800 to 7,300 feet.

More nearly allied to *T. kosciuskoanus* Sl than to any other species, but differently coloured, much smaller, proportionately narrower, prothorax more narrowed to base, which is not wider than apex. Compared with *T. diemenensis* Bates, it is smaller, prothorax with lateral border less reflexed near base; elytra less strongly striate, anterior puncture of third interstices beside third stria and not interrupting the interstices.

TRECHUS GIPPELANDICUS, n sp

Oval, convex. Elytra much wider than prothorax Piceous-black, elytra variegated (pattern testaceous), inflexed margin testaceous, femora and base of antennae light coloured.

Head elongate, narrow; frontal impressions deep, curving outwards anteriorly and posteriorly. Prothorax narrow in proportion to elytra, broader than long (1.5 x 1.65 mm), widest before middle, hardly narrowed behind, wider across base than apex, subdepressed on disc, roundly declivous to sides, basal angles marked, obtuse at summit, base rounded in middle, sloping obliquely inward from each side, marginal channel wide, margin wide, explanate and strongly reflexed at basal angles, basal foveae deep, wide, reaching to lateral channel, median line lightly impressed. Elytra oval (3.6 x 2.5 mm), convex, lightly depressed on disc, strongly roundly declivous to sides and apex, rounded at sides, shoulders rounded; a light sinuosity at each side of apex, six inner striae strongly impressed, simple, 7 and 8 obsolete (except 8 towards apex), stria 1 entire, curving round apex and extending forward in a short deep course opposite extremity of 5; interstices depressed, 3 tri-punctate (two anterior punctures on disc near stria 3, posterior one at extremity of 2), marginal channel narrow along side, explanate just before apical sinuosity. Length, 5.5, breadth, 2.5 mm.

Hab.—Victoria. Unique in my collection, received from Mr C French as from Gippsland.

Allied to *T. subornatellus* Blackb, but larger and with a different elytral pattern. The ground colour of the elytra is piceous, there is a narrow light coloured margin (including interstice 1 towards apex), a testaceous mark extends from a little before the middle of interstice 4 obliquely forward to the side of each elytron, and another similar mark extends across interstices 4—7 a little behind the level of the posterior discal puncture, these two marks unite on interstice 7, interstice 3 has a small plaga in front of the posterior discal puncture. In *T. subornatellus* the testaceous markings form a wavy broken fascia across the elytra above the apical declivity, and there are no testaceous marks on the basal half of the elytra.

TRECHUS BITINCTUS, n sp

Depressed. Head arcuately bisulcate, eyes hemispherical, prothorax transversely subcordate, base lobate as in *T. bipartitus* MacL, elytra truncate-oval, unistriate on each side of suture, each elytron 3-punctate (two discal punctures strongly marked), scutellar striae obsolete, basal border reaching scutellum, abdomen setulose. Upper surface bicoloured; head, prothorax, base and sides of elytra to level with posterior discal puncture rufescent, apex and disc of elytra almost to anterior puncture shining black, with a virescent tinge in some lights, under surface ferruginous, becoming of a lighter shade on abdomen, antennae and legs testaceous.

Head large (0.9 mm across eyes); frontal sulci deep, curved, strongly divergent posteriorly; median frontal space subconvex, wider than lateral spaces, rather convex. Prothorax rather convex, broader than long (0.8 x 1 mm), a little wider across basal angles than across apex, sides strongly rounded anteriorly, gently narrowed behind; basal angles prominent, shortly subdentate with apex blunt; basal curve oblique behind basal angles, bisinuate in a well marked open

curve on each side of median lobe, posterior margin of lobe arcuate, anterior transverse impression deep and curved backwards, posterior transverse impression well marked between basal sinuities, lateral border reflexed. Elytra smooth, suboval (2.1 x 1.5 mm), base wide, sides subparallel, apical curve short, submarginal stria (8) distinct behind humeral angles, its course interruptedly indicated on posterior third. Length, 3.5, breadth, 1.5 mm.

Hab—Northern Territory. Adelaide River.

Three specimens have been examined, one belonging to the collection of the British Museum (type, ticketed "Adelaide R, 91-49"), and two others (one in Coll. Sloane) found by Mr H. W. Brown on the Adelaide River. Closely allied to *T. bipartitus* MacL, from which it differs by its bicoloured elytra. The anterior tarsi in ♂ have the two basal joints dilated with the outer angles dentate.

Tribe Odacanthini

Six years ago I reviewed the tribe Odacanthini, as represented in the Australian fauna (These Proceedings, 1917, 413). Since then I have obtained a new and remarkable species, for which I believe a new genus is required (*cf. Aulacolus, postea*), and, my views on the generic distribution of our species having undergone considerable modification, I now offer a revised tabulation of our genera, which I hope will enable them to be recognised. Some notes are added after the table to show my altered views with regard to some of the genera.

Table of Genera

- | | | | |
|----|------|---|----------------------------|
| 1 | (2) | Head not constricted to a neck, eyes at a normal distance from prothorax | |
| | | | <i>Poracara</i> (1917) |
| 2 | (1) | Head narrowed behind eyes, neck (except rarely) narrow and condyli-form, eyes distant from prothorax | |
| 3 | (14) | Antennae with joints 1-3 glabrous. Tarsi glabrous on upper surface | |
| 4 | (13) | Elytra with punctate striae | |
| 5 | (12) | Antennae with joints 3 and 4 subequal | |
| 6 | (11) | Tarsi with joint 4 entire | |
| 7 | (10) | Prothorax not cylindrical, hardly narrower at apex than base, lateral border always present and reaching base | |
| 8 | (9) | Elytra fully striate | <i>Dicraspeda</i> (1862) |
| 9 | (8) | Elytra striate on basal fourth, laevigate on apical three-fourths | <i>Basistichus</i> (1917). |
| 10 | (7) | Prothorax cylindrical, much narrower at apex than base, lateral border short, not reaching base | <i>Arame</i> (1919) |
| 11 | (6) | Tarsi with joint 4 bifid | <i>Ophionea</i> (1821) |
| 12 | (5) | Antennae with joint 3 elongate (about as long as 4 and 5 together) | <i>Clarencia</i> (1917). |
| 13 | (4) | Elytra fully striate, striae simple | <i>Aulacolus</i> (n.g.) |
| 14 | (3) | Antennae with joint 3 setulose. Tarsi setulose on upper surface | <i>Myrmecodemus</i> (n.g.) |

I do not know Castelnau's genus *Anasis* in nature.

Genus DICRASPEDA

Chaudoir, Bull. Soc. Imp. Nat. Mosc., 1862, 300. *Eudaka*, Castelnau, Trans. Roy. Soc. Vict., viii, 1868, 102; Bates, Ent. Mo. Mag., 1871, viii, 32.

Formerly, I had not taken the genus *Dicraspeda* into account, but now feel compelled to regard it as synonymous with *Eudaka*, which must be merged with

it *E sublaevis* MacI agrees so well with the description of *D brunnea* Chaud, from Celebes, that I believe it to be the same thing, there seem no reasons for referring *E sublaevis* to a different genus from *Odacantha latipennis* MacI, the genotype of *Eudaha*. In These Proceedings, 1917, 414, I gave a synoptic table of the species of *Eudaha*, as then understood by me, all these species may be transferred to *Dicraspeda*, except *Casnomia obscura* Cast, which I would place in *Arame*.

Genus ARAME

The old magazine-genus *Casnomia* has been shown by Mr H E Andrewes to be invalid (Ann Mag Nat Hist, (9), iii, 1919, 477), at the same time he founded a new genus *Arame*, for some Oriental species which had formerly been placed in *Casnomia*. This genus *Arame* will include *Casnomia obscura* Cast.

Genus OPHIONEAE

The genus *Ophionea* has been given a narrow significance by being confined to those species which have the fourth joint of the tarsi bifid, but it seems very doubtful whether this character should be allowed to restrict the limits of this genus, though this is a matter that does not concern the Australian fauna, the two known Australian species of *Ophionea* having the fourth tarsal joint bifid.

OPHIONEAE PUNCTICOLLIS, n sp

Elongate. Prothorax elliptical, subcylindrical, lateral border indicated, pronotum and prosternum punctate, elytra with two white ante-apical spots, punctate-striate, interstices depressed, joint 5 of tarsi deeply bifid. Head nigro-cyanaceous, prothorax and base and apex of elytra reddish, a wide transverse dark cyanaceous band forward from white maculae, legs testaceous, apical third of femora, extreme apex of tibiae, and apices of tarsal joints infusate, antennae infusate, joints 1-4 testaceous.

Head ant-like, convex (1.4 mm across eyes), roundly-obliquely and rather shortly narrowed to the condyliform neck, frontal sulci wide and distinct between antennae, diverging near eyes and extending to basal third of eyes, a submarginal costa between posterior part of each frontal sulcus and eye. Prothorax narrow (1.7 x 1 mm), wider at base than apex, transversely impressed near base, sides lightly arcuate in middle, lightly narrowed to apex, shortly subrectangular near base, upper surface punctate and transversely rugose, punctures and rugae more distinct towards sides, apex with a strong narrow border. Elytra parallel (4 x 2 mm). Length, 8, breadth, 2 mm.

Hab.—Queensland Burdekin River (type, in Coll Sloane), Northern Territory: Darwin (G. F. Hill).

Compared with *O thousseti* Cast, it differs by colour (base of elytra not cyanaceous), head more obliquely narrowed behind eyes, prothorax punctate and with lateral borders developed on anterior half. Compared with the Oriental species known to me (e.g. *O cyaneocephala* Fabr), the head is stouter, more shortly and less obliquely narrowed behind eyes, prothorax less rounded at widest part, much less narrowed to apex, etc.

Genus *AULACOLIUS*, n. g.

Head glabrous, diamond-shaped, constricted by an elongate slope to a narrow condyliform neck, antennae with joints 1-3 glabrous, joints 3 and 4 subequal. Prothorax oviform, impunctate—except on the narrow basal part, pronotum gibbous, transversely striolate, impunctate, lateral borders well developed, not reaching base, lateral channel with four or five widely spaced setae on the ampliate part of sides. Prosternum convex, sides visible from above. Elytra ovate, twice as wide as prothorax, fully striate, disc transversely impressed across interstices 2-4, striae entire, simple, interstices equal, 3, 5 and 7 seriatly pluripunctate, the punctures bearing rather long setae, and placed in two rows on outer sides of interstices 3 and 5, four punctures on interstice 1 beside scutellar striae. Tarsi glabrous on upper surface, joint 4 entire.

I do not know any genus to which the species described below as *Aulacolus triordinatus* can be referred. It cannot be placed far from *Lachnothorax*, but is distinct by pronotum and striae of elytra impunctate, head and pronotum without setae, except the fixed ones.

AULACOLIUS TRIORDINATUS, n. sp.

♀ Head diamond-shaped, neck narrow, condyliform, prothorax oviform, longer than broad, ampliate on sides, impunctate except near base, lateral borders well developed, elytra wide, disc transversely impressed near basal third, striae entire, deep, simple, interstices depressed, 3, 5 and 7 pluripunctate, others laevigate. Black, apex and apical half of inflexed margins testaceous, antennae piceous, base more lightly coloured, legs testaceous, coxae and posterior trochanters clear brown, femora at apex, tibiae at base, and apex infusate, tarsi infusate, abdomen with segments 5 and 6, also sides of 3 and 4 clear brown.

Head convex, impunctate, glabrous (1.4 mm across eyes), strongly obliquely angustate to base, eyes convex, prominent. Prothorax a little narrower than head (1.6 x 1.2 mm), sides roundly ampliate in middle, decidedly rounded anteriorly, strongly narrowed posteriorly, strongly sinuate at posterior fifth, basal part rugose-punctate, defined by a strong transverse impression, lateral border distinct, except behind transverse basal impression, lateral channel well developed and bearing four or five setae on ampliate part of sides; pronotum gibbous, transversely striolate. Elytra truncate-oval (3.3 x 2.6 mm), declivous to peduncle; apex wide, apical curve short, a little oblique outwards from interstice 4, striae strongly impressed, smooth, an elongate impunctate striae at base of interstice 1, interstices depressed, inner ones a little raised towards apex, odd ones seriatly setigero-punctate, even ones nitid, impunctate, four or five setigerous punctures along outer side of scutellar striae; lateral channel impunctate, inturned to meet stria 8 near base, inflexed margins glabrous, impunctate. Under surface impunctate, except peduncle and base of prothorax. Length, 8; breadth, 2.6 mm.

Hab.—Northern Territory. Darwin. Unique in Coll. Sloane. Mr. Gerald F. Hill found one specimen which he generously presented to me.

This species is at once differentiated from all our other *Odocanthodes* by the striae of the elytra being entire and impunctate.

MYRMECODEMUS, n. g.

Head strongly constricted in a curve to a short condyliform neck, antennae with joint 3 about equal in length to 4, sparsely setulose. Prothorax oviform, base narrow, defined by an encircling sulcus, pronotum gibbous, sparsely setose, bordered on sides; lateral channel with several setae at ampliate part of sides. Prosternum convex, smooth, sides visible from above. Elytra ovate, about twice as wide as prothorax, transversely impressed at basal third, sparsely seriate-setose. Tarsi sparsely setose on upper surface, joint 4 entire.

Genotype, *Casnomia riverinae* Sl.

This new genus is allied to *Selina*, but has the neck short (not forming a very narrow stalk to the head) and the third joint of the antennae not elongate. It is founded on *Casnomia riverinae* Sl., to which *C. globulicollis* MacL., is closely allied, also *Lachnothorax formicoides* Sl. *Lachnothorax palustris* Sl., is very distinct from the three species mentioned, and perhaps is not actually congeneric with them, but it is more in place in the genus *Myrmecodemus* than anywhere else. I was mistaken in referring these four species to the genus *Lachnothorax* in 1917, but the tabulation then proposed will enable them to be recognized. The typical species of *Lachnothorax* have joint 3 of the antennae glabrous.

Tribe Panagaeini.

Genus CRASPEDOPHORUS.

Hope, Col. Man, ii, 1838, 165, Chaudoir, Ann Soc Ent Belg, xxi, 1878, 90—*Eudema* Castelnau, Hist Nat Ins, I, 1840, 137, Trans Roy Soc Vict, viii, 1868, 145, Chaudoir, *Id.*, 133—*Epicosmus* Chaudoir, Bull Soc Imp Nat Mosc, iv, 1846, 512, Ann Soc Ent Belg, xvi, 104, Sloane, Proc Linn Soc N S W, 1903, 566.

In his *Essai Monographique sur les Panagétides* (1878) Chaudoir used the three names *Craspedophorus*, *Eudema* and *Epicosmus* as being each entitled to rank as a distinct genus, and in doing so he used *Craspedophorus* rightly, but it is impossible to follow him in his ideas as to the recognition and use of *Eudema* and *Epicosmus*. The facts are, as has been explained by Mr H. E. Andrewes (Trans Ent Soc Lond, 1919, 126), that *Eudema* Castelnau is synonymous with *Craspedophorus* Hope, while the type of *Epicosmus* is *Carabus angulatus* Fabr., which is erroneously referred to under the name of *Eudema bifasciatum* Fabr. (a name never used by Fabricius) in Chaudoir's monograph, where it forms the only species of the genus *Eudema*. I support Mr. Andrewes's view that both *Eudema* and *Epicosmus* should be sunk as synonyms of *Craspedophorus*.

In These Proceedings for 1903, 566, under *Epicosmus*, I dealt with our species, giving a table of species and proposing three new specific names, but I had too little data then, and now see that my *E. oberulus* is conspecific with *E. rockhamptonensis* Cast., and *E. froggatti* with *E. australasiae* Chand. I now have two new species to describe, and give below a new table of species leading off from *Cr. parvulus* MacL., which is the most nearly related of our species to those of Java and Borneo. It seems to me certain that the Australian Panagaeini have been derived from the Oriental region.

Table of Australian Species

- 1 (16) Prothorax with posterior angles rectangular and dentate
- 2 (11) Elytra with maculae orange, or lemon-coloured
- 3 (4) Elytra somewhat lightly furrowed, interstices roundly convex, equal, setose-punctate 9.5 mm *parvulus* MacL
- 4 (3) Elytra deeply furrowed, interstices 3, 5 and 7 rather stronger than others
- 5 (8) Elytra with two (rarely one) fixed punctures on interstice 3, maculae reaching to third stria
- 6 (7) Prothorax strongly sinuate-angustate to base 12-13 mm *comptus* Laf
- 7 (6) Prothorax not sinuately narrowed to base 12.5-13.5 mm *rockhamptonensis* Cast
- 8 (5) Elytra without fixed punctures on interstice 3, maculae reaching to fourth stria
- 9 (10) Head narrow before eyes, elytral interstices evidently setose-punctate 11-12.5 mm *angusticeps* Sl
- 10 (9) Head stout before eyes, elytral interstices nitid, hardly punctate, 13.5-15.5 mm *banksi* Sl
- 11 (2) Elytra with maculae red (Interstices 3, 5 and 7 more raised than others)
- 12 (15) Form oblong, subdepressed
- 13 (14) Elytra with third interstice unpunctate near posterior macula 15.5-18 mm *alternans* Cast
- 14 (13) Elytra with third interstice impunctate 12-14 mm *masteri* Sl
- 15 (12) Form oval, prothorax and elytra convex Interstices 1 and 2 of elytra evidently depressed below 3 10-12 mm *australasiae* Chaud
- 16 (1) Prothorax with posterior angles rounded off
- 17 (18) Anterior macula of elytra reaching to third stria 17.5-21 mm *insignis* Schaum
- 18 (17) Anterior macula of elytra reaching to fourth stria 17 mm *macleani* Sl

CRASPEDOPHORUS ANGUSTICEPS, n sp

Oval Head narrow, prothorax small, elytra with interstices very convex, almost equal Black, four citron-coloured maculae on elytra, anterior pair distant from base extending across interstices 5-9, posterior pair small, extending across interstices 5-8, uneven on anterior and posterior edges

Head elongate (1.6 mm across eyes), frontal part longer than broad (1.3 x 1.2 mm), finely punctate, laevigate anteriorly Prothorax broader than long (2.6 x 3.2 mm), a little convex on anterior part of disc, widest behind middle, strongly narrowed to apex (1.6 mm), obliquely narrowed to base (2.4 mm.); anterior angles narrow, obtuse, lateral margins declivous anteriorly, widely upturned posteriorly, lateral border narrow, basal angles subdentate Elytra convex, oval (6.8 x 4.7 mm), interstices sparsely setose-punctate, 3-7 subequal, 5 dilated and 4 narrowed at posterior macula. Length, 11-12.5, breadth, 4.5-5.2 mm

Hab—Queensland Mareeba (Sloane), Cooktown (Brown), Coen (Hacker). Type in Coll Sloane Twelve specimens have been examined, most of which were found by me under logs beside the railway station at Mareeba in June

This species is characterised by its small size, narrow head, interstice 3 of elytra without fixed punctures, maculae of elytra pale yellow, the anterior macula is transverse, and consists of five spots across interstices 5 to 9, the spots

on interstices 8 and 9 are longer than the three inner spots, the posterior macula is smaller, and consists of four spots across interstices 5—8, the spot on interstices 6 shortest, the inflexed margins usually have a faint reddish mark near the edge below the anterior elytral macula, but sometimes this mark is absent. The interstices of the elytra are more setose than usual, the setae rising from small punctures on the interstices, but not from the large punctures of the striae

CRAEPEDOPHORUS BANKSI, n sp

Elongate-oval, subdepressed Head wide, prothorax transverse, strongly punctate, subobliquely (roundly) narrowed to base, elytra with interstices subequal Black, four citron-coloured maculae on elytra, anterior pair extending across interstices 5—9, posterior pair narrow, extending across interstices 5—8, anterior and posterior margins uneven, spots on interstices 6 and 8 shorter than those on 5 and 7, inflexed margin with a reddish mark below anterior macula

Head stout (2.45 mm across eyes), frontal part wide (1.6 x 1.7 mm), frontal sulci punctate, interspace convex, laevigate anteriorly, punctate posteriorly between eyes, antennae elongate Prothorax transverse (3.5 x 4.5), widest behind middle, lightly convex (but not roundly raised) in middle of disc, sides strongly and roundly narrowed to apex (2.4 mm), subobliquely and rather roundly narrowed to base (3 mm), anterior angles rounded, basal angles feebly dentate, median line well marked, lateral basal impressions long, sulciform, placed opposite stria 4 of elytra. Elytra ovate (9 x 5.65 mm), lightly rounded at sides, lightly sinuate on each side of apex, disc depressed between third interstices, striae very deep, crenulate, interstices 1—8 strongly convex, their summits nitid, 3 without fixed setiferous punctures, 3, 5, and 7 wider than others, 4 decidedly narrowed at posterior macula, 5 swollen on inner side at posterior macula Length, 13.5—15.5, breadth, 5.4—6.2 mm

Hab—Queensland Cooktown and Upper Normanby River (Sloane), Kuranda (Dodd), Cairns Type in Coll Sloane I found several specimens under Eucalyptus logs on the sides of Mount Cook at Cooktown, and at King's Plains cattle station on the Normanby River

A large species which differs from *Cr alternans* Cast, by its shorter and wider head; shorter and wider prothorax, not sinuate on sides posteriorly, elytra with the maculae not extending on to interstice 4, interstice 5 swollen and 4 angustate at posterior macula, the alternate interstices not so much raised above the others It is very like *Cr rockhamptonensis* Cast, which it resembles in the colour of the maculae of the elytra, but it differs by antennae longer, the joints after 3 longer and slenderer, prothorax less strongly declivous to sides before middle, lateral margins wider; maculae of elytra not extending on to interstice 4, the posterior macula smaller, more uneven on anterior and posterior margins, the spot on interstice 6 shortest, interstice 5 swollen and 4 angustate at posterior macula

Tribe *Laciniini*.

Genus *DICROCHILE*.

Table of Australian Species

- | | | |
|-------|--|----------------------------|
| 1 (4) | Elytra with third interstice 3-punctate. | |
| 2 (3) | ♀ Elytra nitid | <i>D quadricollis</i> Cast |
| 3 (2) | ♀ Elytra opaque, shagreened | <i>D ventralis</i> Blackb |
| 4 (1) | Elytra with third interstice 2-punctate | |

- 5 (6) Striae of elytra deep, crenulate *D. goryi* Boyd.
 6 (5) Striae of elytra simple
 7 (12) Interstices of elytra not punctulate
 8 (11) Size moderate 12 mm
 9 (10) Prothorax transverse (2.5 x 3.4 mm), striae of elytra shallow, interstices flat, nitid in ♂, opaque in ♀ *D. minuta* Cast.
 10 (9) Prothorax quadrate (2.3 x 3 mm), striae of elytra deep, interstices convex, nitid in both sexes *D. brevicollis* Chaud
 11 (8) Size large, elytra nitid in ♀ 21 mm *D. gigas* Cast
 12 (7) Interstices of elytra punctulate *D. punctulata* Sl
 I have not been able to identify *D. montana* Cast, *D. punctatostriata* Cast, and *D. punctipennis* Cast

DICROCHILE PUNCTULATA, n.sp

♀ Elliptical, depressed Prothorax transversely cordate, elytra lightly striate, interstices depressed, punctulate, 3 bi-punctate beside stria 2 Black, nitid

Head transverse-quadrate (2.75 mm across eyes), front concave, eyes prominent, hemispherical Prothorax transverse (2.5 x 3.6 mm), wider across apex (2.75 mm) than base (2.63 mm), nitid on disc, a little rough and minutely punctulate towards sides, margins wide, reflexed (strongly so posteriorly); lateral basal impressions wide, basal angles obtuse Elytra parallel-oval (9 x 5.5 mm), striae fine, subcrenulate, interstices flat, rather closely covered with small punctures, these punctures more numerous on even than on odd interstices Ventral segments 3-5 setigero-punctate on each side of middle Length, 14.5, breadth, 5.5 mm

Hab—Northern Territory Darwin Unique in Coll Sloane Kindly given to me by Mr G F Hill, I have seen other specimens from East Alligator River in the National Museum, Melbourne

It is distinguished from all other Australian species of the genus by the punctulate interstices of the elytra, the puncturation is denser (about 4 rows) on the even interstices, on the odd interstices it has a tendency to be arranged in two rows, one along each side of the interstice Its affinity seems to be with *D. gigas* Cast, which it resembles in shape of head and prothorax.

Tribe Lebiini.

XANTHOPHOXA WILSONI, n.sp

Narrow, elongate Prothorax sinuate posteriorly, basal angles rectangular; elytra lightly narrowed to base, third interstice 3-punctate. Elytra brown, interstices 2, 4 and 6, and lateral margin of a dull testaceous colour, brownish near apex; prothorax testaceous at sides, brownish on disc; head testaceous, sometimes rather brownish on vertex, under surface testaceous, abdomen brownish; legs and antennae testaceous

Head convex (1.15 mm across eyes), obliquely narrowed behind eyes, setulose on vertex and beside eyes Prothorax broader than long (1.1 x 1.4 mm.), depressed and explanate at sides, lightly convex on disc, sparsely covered with small setules arising from very small punctures, sides lightly rounded on anterior two-thirds, sinuate posteriorly and meeting base at right angles, basal angles rectangular Elytra subparallel, widest about apical fourth (3.5 x 2 mm.), subdepressed on disc, strongly declivous at sides from interstice 7, lightly declivous

to base and apex, striae deep, finely crenulate; interstices subconvex, minutely, but sparsely, setulose punctate, 3 with three strong punctures, 5 and 7 with some punctures stronger than others along outer side. Under surface (including prosternum and metasternum) sparsely setulose ♂ with one, ♀ with two setae at each side of apex of abdomen. Length, 5.7—6.5, breadth, 2 mm.

Hab—Victoria Mount Donna Buang, 4,080 feet. Colls Wilson and Sloane. Mr F. E. Wilson sent me four specimens taken by him in tussocks of grass on Mt Donna Buang, near Warburton.

This is a very distinct species, more allied to *X. infusata* Chaud. than to any other described species, but easily distinguished by size smaller, head more convex, neck thicker, prothorax somewhat similar in shape, but with basal angles less prominent, elytra differently coloured. The longitudinally striped pattern of the elytra is peculiar to this species.

XANTHOPHOEA CARTERI, n. sp.

Narrow, elongate, depressed. Prothorax sinuate posteriorly, basal angles rectangular, elytra lightly narrowed to base, interstices 3, 5 and 7 bearing fixed setae. Testaceous, disc of prothorax with an infusate plaga on each side, elytra 8-vittate, central vitta on interstice 1 of each elytron, lateral vitta on interstices 6—8, an oblique broken fascia of piceous spots on each elytron from posterior third of lateral vitta to apex of sutural vitta, under surface wholly testaceous.

Head convex (1.26 mm across eyes), obliquely narrowed behind eyes, setulose, joint 3 of antennae finely setulose. Prothorax broader than long (1.25 x 1.45 mm), depressed and explanate at sides, lightly convex on disc, sparsely covered with small setules arising from very small punctures; sides rounded on anterior two-thirds, sinuate posteriorly, basal angles acute. Elytra widest about apical fourth (3.8 x 2.2 mm.), striae deep, crenulate, interstices hardly convex, distinctly punctate, 3 bearing six, 5 four, and 7 three strong punctures with macrochaetae. Under surface, including prosternum and metasternum, sparsely setulose ♂, with one seta at each side of apex of abdomen. Length, 6.5, breadth, 2.2 mm.

Hab—N. S. Wales. Gosford (Carter), Wahrenonga (Sloane). Type in Coll. Sloane. I first received this species from Mr H. J. Carter; subsequently I found a specimen in July, hiding in the leaves of a grass-tree (*Xanthorrhoea hastula*).

A distinct species allied to *X. wilsoni* Sl., from which it differs by size larger, basal angles of prothorax more acute, elytra more coarsely punctate, pattern different, interstices 2—5 testaceous on anterior two-thirds, and each with a small piceous spot on apical third (the spot on 2 united with the apex of the sutural vitta, that on 5 united with external vitta, that on 3 placed obliquely between those on 2 and 5, that on 4 opposite that on 2).

XANTHOPHOEA PARALLELA Chaudoir.

(= *X. ornata* Sloane)

I now feel no doubt but that *X. parallela* Chaud., (1872), is the same species as the one I subsequently named *X. ornata* (1910). It probably has a wide range, I described it from specimens found hiding in the leaves of the grass-trees at Berowra, near Sydney; there are specimens in the Macleay Museum ticketed King George's Sound.

XANTHOPHOEA LONGICOLLIS Macleay (1864)

(= *X ferruginea* Chaudoir, 1872 = *Demetrius rufescens* Macleay, 1887)*

There seems to me no doubt but that *Cymindus longicollis* Macleay is the same thing as *X ferruginea* Chaud and *Demetrius rufescens* Macleay. It ranges from the Hunter River at least as far north as Cooktown. It is always obtained by being beaten from the foliage of shrubs.

XANTHOPHOEA TRIVITTATA, n sp

♀ Elongate. Head convex, obliquely narrowed behind eyes, impunctate, antennae with three basal joints pubescent, prothorax subquadrate, sides emarginate posteriorly, basal angles rectangular, disc impunctate, elytra parallel, crenulate-striate, interstices punctulate, 3 unipunctate about apical third, apex of abdomen (?) 4-setose, tarsi setulose on upper surface. Testaceous, elytra paler than head and prothorax, disc of prothorax with a black plaga on each side, elytra with three black vittae, central vitta on interstices 1 and 2, extending to apical sixth, lateral vittae on interstices 6-8, extending to extremity of 7, apex of abdomen infusate.

Head stout (1.7 mm across eyes), transversely impressed posteriorly, orbits well developed and oblique behind eyes. Prothorax slightly broader than long (1.8 x 2 mm), a little wider across base (1.65 mm) than apex (1.5 mm), apex truncate, anterior angles obtuse, sides lightly rounded, lightly sinuate posteriorly, base bisinuate, squarely truncate on each side, basal angles rather prominent, lateral margins wide, punctate, anterior marginal seta before middle at widest part, very near edge, median line strongly impressed. Elytra subparallel, a little narrowed from posterior third to base, much wider than prothorax (5.5 x 3.2 mm), apex arcuate-truncate, external angles rounded off, interstices lightly convex, punctuation stronger on interstices 6-8 than on others. Length, 8-9.5, breadth, 3.2 mm.

Hab—Queensland. Stradbroke Island (H. J. Carter). I have examined three specimens given to me by Mr. H. J. Carter, owing to the two smaller specimens having their elytra spread I have only been able to measure the width of the largest specimen.

A distinct species allied to *X parallela* Chaud, from which it differs greatly by smaller size, head more strongly narrowed and not black behind eyes, prothorax more rounded on anterior part of sides, more strongly sinuate posteriorly, basal angles much more sharply marked, lateral channel much deeper, lateral border more widely and strongly reflexed, sutural vitta of elytra not reaching apex.

Genus *PHILOFOCARABUS**PHILOFOCARABUS PARVICEPS*, n sp

Elongate-oval, depressed, upper surface glabrous. Head small, strongly constricted to a narrow neck, prothorax narrow, subquadrate, elytra lightly narrowed to base, lightly striate. Brownish testaceous, elytra with a wide infusate fascia on apical half, this infuscation extending rather faintly forward along suture to base and spreading over interstices 1-4 near base, apex and a narrow lateral margin (including interstice 9) testaceous, head, antennae, and tarsi reddish.

Head obcordate (1.23 mm across eyes), depressed, very finely shagreened and microscopically punctate, strongly roundly-obliquely constricted behind, eyes prominent, rounded continuously with the curve of the posterior part of orbits. Prothorax depressed, subquadrate (1.25 x 1.65 mm), ampliate behind apex, subparallel on sides, broadest at anterior third, wider across base than apex, finely shagreened, disc very finely transversely striolate, lateral margins wide, lateral basal impressions wide, concave, sides very little narrowed posteriorly, subsinuate before base, median line distinct, base lightly arcuate in middle, lightly oblique on each side, angles marked, but obtuse at summit. Elytra subquadrate with angles rounded (4.2 x 2.85 mm), widest about middle, sides lightly rounded, apex wide, truncate in a light curve, striae fine, shallow, crenulate, interstices depressed, shagreened, sparsely microscopically punctate, 3 bipunctate, the punctures small (one just before, the other just behind the dark fascia), punctures of 9 small, not numerous, interrupted in middle. Length 7.7, breadth, 2.85 mm.

Hab—NS Wales. Type in British Museum ticketed "Illawarra, G. E. Bryant, 2 x 08." I have seen it from the Blue Mountains.

This species has somewhat the appearance of a species of *Xanthophoea*. The head is unusually small, and the prothorax unusually narrow, comparing it with *Ph. mastersi* Mael, it differs conspicuously by these characters, amongst others. It seems to come near *Diabaneus collaris* Black, (unknown to me in nature) but evidently is differently coloured, and I expect it will prove to have the head smaller, neck narrower, prothorax less narrowed to base and less sinuate on the sides. Owing to the upper surface being shagreened its colours are rather dull.

Genus AGONOCILIA

AGONOCILIA OVALIS, n. sp.

Oval, rather convex. Head and prothorax piceous brown, elytra black and flavous, the flavous area covering most of the disc, irregular on outer margin, broken into along basal part of suture and on middle of each side by intrusions of the black circumferential area, a narrow broken zig-zag fascia extending backwards in a faintly marked course across disc of elytra between inner sides of lateral intrusions from black area, lateral channel flavous, legs and antennae testaceous.

Head smooth, with a few microscopic punctures. Prothorax transverse, much wider across base than apex, ampliate behind the widely rounded anterior angles, sparsely covered with short fine hairs, disc rather convex, sides explanate, finely punctate, not angulate at position of lateral seta, lightly obliquely narrowed to base, basal angles subrectangular, obtuse at apex. Elytra lightly convex, oval, densely and finely setulose-punctate, apex wide, striae not marked, but interstices perceptible on disc. Length, 4, breadth, 1.75 mm.

Hab—Queensland. Type in British Museum ticketed "Kuranda G. E. Bryant 1.vii.09."

It is not unlike a species found by Dr E. Mjöberg on the Bellenden Ker Mountains, which I have named *A. intricata*, but differs by having the discal flavous area of the elytra less decidedly divided by a distinct broken black fascia, size larger; head and prothorax less strongly punctate, prothorax with anterior angles more widely rounded, lateral margins much wider. It may be noted that the flavous discal area almost touches the lateral margin about apical fifth.

NEW TERMITES FROM CENTRAL AND SOUTH-EAST AUSTRALIA

By GERALD F HILL.

(Twenty-one Text-figures)

[Read 26th March, 1923]

One new species of *Coptotermes* and two new species of *Eutermes* are described in this paper. With these additions to the list of Australian species, the former genus now contains six species and the latter twenty-eight species and one variety.

I am indebted to the Authorities of the South Australian Museum and to Messrs W. W. Froggatt, F. E. Wilson and W. F. Hill for the privilege of examining the material herein discussed.

The methods of recording measurements and colours are the same as those referred to in previous papers. The Text-figures were drawn by the writer with the aid of a camera lucida and are from specimens in the type series.

COPTOTERMES SEDULUS, n. sp. (Text-figs 1-7)

Image (Text-figs 1-4.)

Colour Very dark brown, head and pronotum darkest, legs and wing veins a little lighter than tergites of abdomen. Antennae brown, first two joints very dark. Wing membrane fuliginous.

Head (Text-fig 1) rather small, moderately setaceous, rounded on the sides and behind, front flattened, fontanelle very small, oval, ocelli large, oval, well separated (0.048) from the eyes, eyes large (0.272 x 0.304), prominent, finely faceted, lower margin separated from the lower (lateral) margin of the head by a space of 0.329, Post-clypeus short, one-fourth as long as wide, light brown like tarsi, anteclypeus large, hyaline, anterior margin slightly produced in the middle, labrum large, rounded on the sides and in front; antennae (Text-fig 2) 19-jointed, 1st joint large, a little swollen at apex, 2nd half as long as 1st and much narrower, 3rd very short, less than half as long as 2nd and much narrower, smallest of all, 4th and 5th globose, equal.

Thorax Pronotum (Text-fig 3) nearly as wide as head, concave in front, rounded on the sides, slightly sinuate behind, moderately setaceous like head; posterior margin of meso- and metanotum slightly more rounded than pronotum.

Legs moderately short and slender, claws and tibial spurs large and dark coloured, tarsi pale coloured, fourth tarsal long and slender, longer than remaining joints together.

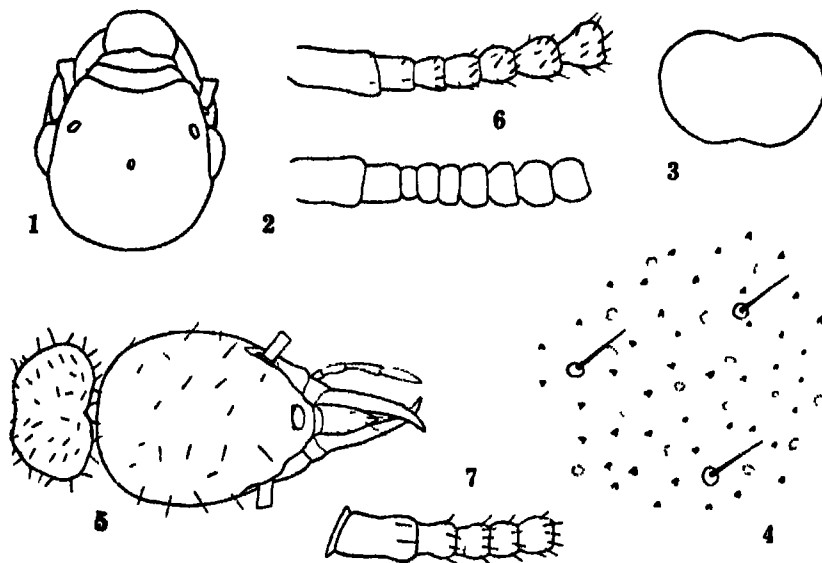
Wings Wing-stumps setaceous as in pronotum, distal margin convex, membrane clothed with setae and densely but minutely sculptured (Text-fig. 4), costal, apical and distal half of the posterior margin very setaceous, costa and radius dark and very distinct, the latter setaceous to the apex of the wing and sometimes obscurely branched towards the former, or to the median vein, or to the apex, median vein very distinct at the base but soon becoming invisible, that of the forewing branching within the wing-stump, that of the hindwing beyond the suture, cubitus with a varying number of branches, forked or simple, only the proximal short branches distinctly visible

Abdomen cylindrical, bluntly rounded at the apex, tergites clothed as in pronotum, cerci short and moderately stout

Measurements

Length with wings 15.00 mm, without wings 8.00

Head: from posterior margin to apex of labrum, long 1.36, from posterior



Coptotermes sedulus, n.sp.

Text-figs 1-4 Imago—1 Head from above, 2 antenna, proximal segments 3 pronotum, 4 wing-membrane (greatly magnified)

Text-figs 5-6 Soldier—5 Head and pronotum, 6 antenna, proximal segments

Text-fig 7 Worker—Antenna, proximal segments

margin to clypeo-frontal suture, long 0.94, at and including eyes, wide 1.18

Antennae (19-jointed), long 1.92

Pronotum, long 0.70, wide 1.03

Tibia m., long 1.00

Wings. forewings, long 11.00, wide 3.15, hindwings, long 10.50, wide 3.30

Abdomen, wide 1.55.

Soldier (Text-figs 5-6)

Colour. Head and antennae ochraceous, mandibles castaneous, pronotum bordered with yellow, legs and abdomen yellowish-white, the latter, as well as

meso- and metanotum, with an indistinct brown pattern along the dorso-median line.

Head (Text-fig 5) widest midway between base and fontanelle, rounded behind and on the sides, sloping in from the posterior margin of the antennal fossae to the base of the mandibles, with scattered long reddish setae, fontanelle relatively large (0.175 diam), with dark coloured dorsal margin; anteclypeus hyaline, labrum long and narrow, acuminate; antennae (Text-fig 6) 16-jointed, the 1st long and moderately slender, 2nd about two-fifths as long as 1st and much narrower, 3rd shortest of all, narrowed at the base, 4th as long as 2nd, oval 5th as long as 4th, more rounded, 6th much larger and more stalked than 5th, 7th turbinate

Thorax Pronotum (Text-fig 5) small and much narrower than head, deeply emarginate in front, slightly sinuate behind, the margin yellow, the whole upper surface with scanty reddish setae as on head, mesonotum about as wide as pronotum, metanotum slightly wider, clothing and posterior margin of each similar to pronotum

Legs rather stout, clothed with numerous long and short reddish setae

Abdomen elongate, bluntly rounded at the apex, the segments clothed similarly to the legs, cerci large.

Measurements of

	<i>U. sedulus</i>	<i>U. lacteus</i>	<i>C. michaelsem</i>
Total length	5.30	—	4.30*
Head, with mandibles, long	2.02	2.50	1.80
" , posterior margin to labral suture, long	1.36	1.60	—
" , posterior margin to anterior margin of fontanelle, long	1.27	1.41	1.22
" , wide	1.12	1.18	0.96
Thorax and abdomen, long	3.66	—	—
Antennae, long	1.64	—	1.36
Pronotum, long	0.47	0.47	—
" , wide	0.82	0.89	—
Mesonotum, wide	0.84	—	—
Metanotum, wide	0.94	—	—
Tibia III, long	1.03	1.12	0.84
Abdomen, wide	1.17	—	—

Worker. (Text-fig 7)

Colour Head yellow with ferruginous spot at postero-lateral angles of clypeus, remainder of insect almost uniform pale straw, head, thorax, abdomen and legs clothed with long and short, conspicuous, reddish setae.

Head large, basal half from posterior margin of antennal fossae almost hemispherical, the widest part in line with the insertion of the antennae, post-clypeus large, anterior and posterior borders arcuate, labrum strongly convex, large, rounded on the sides and in front; antennae (Text-fig 7) 16-jointed, 1st joint large, narrowed in the middle, 2nd half as long as 1st, narrowed at the base, 3rd nearly as long as 2nd, showing faint indication of division at the preximal third, 4th and 5th very little longer than 3rd

Thorax Pronotum much narrower than head, similar to that of soldier but slightly more rounded behind, mesonotum (0.94 wide) a little wider than pronotum and a little narrower than metanotum (0.99 wide).

* F. Silvestri Die fauna Sudwest Australiens, Isoptera, Bd 2, No 17, 1909

Legs moderately long and stout, markedly setaceous; claws long and slender
Abdomen large, widest in the middle, tapered to the bluntly pointed apex, cerci large, narrow at the base, setaceous

Measurements.

Total length, 6.25 mm.

Head base to apex of labrum, long 1.45, wide 1.14.

Thorax and abdomen, long 4.80.

Pronotum, long 0.47; wide 0.80.

Tibia in, long 1.00

Abdomen, wide 1.55.

Described from a small nest series comprising workers, soldiers and two alate imagoes (3.9.21), eight imagoes captured on the wing, and numerous other series comprising workers and soldiers only. From the collectors' notes it is evident that this species closely resembles *C. acinaciformis* Froggatt and *C. lacteus* Froggatt in its habits. It is probable that it is the species generally responsible for the destruction of fruit trees, vines, root crops, building timber, fence posts, etc., in Victoria, where it appears to be the predominant species of this genus. My collection of thirty nest series of *Coptotermes* from various parts of Victoria comprises twenty-nine series which I refer to the proposed new species and one series, from Rochester District, which may be referable to *C. lacteus*.

Through the courtesy of Mr W. W. Froggatt, I have been able to compare *C. sedulus* with the types of *C. lacteus* Froggatt and *C. acinaciformis* Froggatt, from Shoalhaven, N.S.W., and Hall's Creek, N.W.A., respectively. In *lacteus* the head is hazel (Ridgway); it differs from *sedulus* otherwise in having a longer and broader head, larger pronotum, noticeably wider mesonotum and considerably longer (russet coloured) wings. *C. acinaciformis* is a markedly distinct species. Professor Silvestri has kindly examined the alate form of *sedulus* and has expressed the opinion that it is specifically distinct from both *lacteus* and *michaelsem*. The latter is the smallest of the Australian species and has two antennal joints less than *sedulus* in both imago and soldier. The heads of the soldiers of *sedulus* are markedly longer and more rounded than those of *michaelsem*, but shorter and narrower than those of *lacteus*. *C. raffrayi* Wasmann is a much larger and more robust species. The only remaining described Australian species is *C. australis* Walker, an inadequately described but apparently very distinct species from South Australia.

Types in the writer's collection, paratypes in the collections of Professors F. Silvestri and S. F. Light. *Locality*—Victoria: Belgrave, Healesville, Lakes Entrance (F. E. Wilson), Ferntree Gully (F. P. Spry), Seaford, Riddell (W. F. Hill).

EUTERMES FIELDI, n. sp. (Text-figs. 8-13)

Imago (Text-figs. 8-10)

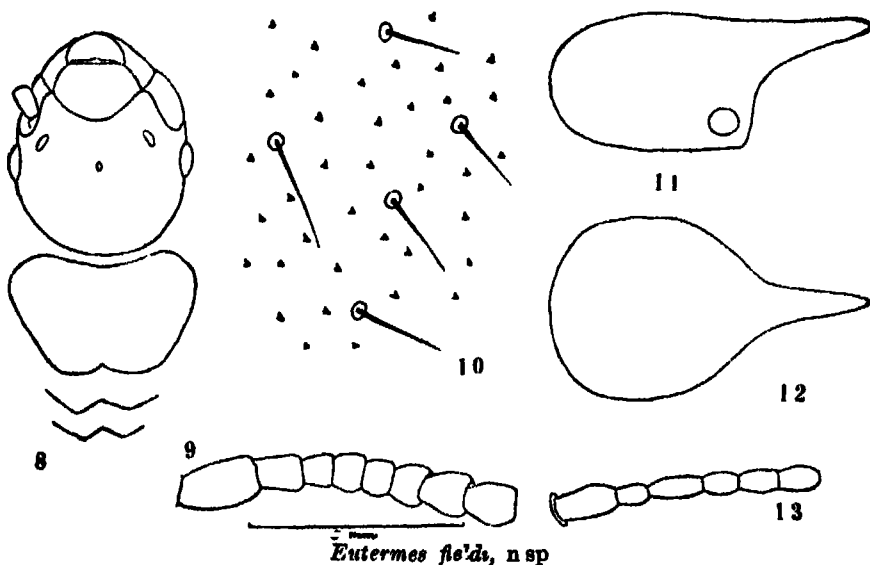
Colour. Head and thorax dark castaneous, clypeus, antennae, legs and tergites of abdomen brussels-brown, sternites a little lighter, wings light smoky, with dark costa and radius.

Head (Text-fig. 8) small, with scanty small pale setae (? abraded), broadly rounded behind, rather longer than wide, frontoconave; fontanelle small, indistinct, in line with middle of eyes; eyes moderately large (0.282) and projecting, situated near (.094) lower margin of head, ocelli small, narrow, widely separated from eyes; postclypeus very large and convex, more than half as long

as wide (0.330 x 0.565), arcuate behind, nearly straight in front, anteclypeus very short, labrum short and broad, hardly covering apex of mandibles, antennae (Text-fig 9) of doubtful number of joints, 1st large, broad, 2nd half as long as 1st, narrowed at base, 3rd short, narrowest of all, 4th and 5th about as long as 3rd but wider, 6th longer and wider than 4th and 5th, 7th and 8th larger than 6th, equal, other joints missing

Thorax (Text-fig 8) Pronotum large, a little wider than head, anterior margin slightly raised, sides sloping back sharply to slightly emarginate posterior margin, meso- and metathorax with rounded sides and broadly emarginate posterior margin

Wings Wing-stumps small, equal, moderately setaceous, suture straight. Wings small, costa and radius dark, media indistinct except at base, cubitus with about 12 inferior branches, only the first four or five of which are distinct



Eutermes fle'de, n. sp.

Text-figs 8-10 Imago—8 Head, pronotum, and posterior margin of meso- and metanotum, 9 antenna, proximal segments, 10 wing-membrane (greatly magnified)

Text-figs 11-13 Soldier—11 Head in profile, 12 head from above, 13 antenna, proximal segments

Wing-membrane (Text-fig 10) clothed with numerous small setae, sculpturing apparently in the form of minute blunt spines (visible under high magnification only)

Measurements.

Length with wings 13.50, without wings 8.00 mm.

Head from posterior margin to apex of labrum, long 1.70; at and including eyes, wide 1.22

Pronotum long 0.75, wide 1.24

Wings forewings, long 9.00, wide 2.35, hindwings, long 8.75, wide 2.60

Tibia m., long 1.50

Abdomen, wide 2.25

Soldier (Text-figs 11-13)

Colour: Head uniform orange-rufous, thorax yellow-ochre, anterior half of pronotum darker than remainder, legs paler

Head (Text-figs 11 and 12) small, rounded behind in dorsal aspect, snout short, about half as long as remainder of head, antennae (Text-fig 13) of doubtful number of joints, 1st long and moderately stout, 2nd short and narrow, half as long as 1st and very much narrower, 3rd very long and narrow, nearly as long as 1st and about as wide as 2nd, 4th a little longer and wider than 2nd, more rounded, 5th and 6th longer than 4th, subequal

Pronotum small, a little more than half as wide as head, anterior half sharply bent up and narrowed anteriorly, posterior margin rounded, with hardly appreciable emargination; mesonotum much narrower than pronotum or metanotum

Legs moderately long, slender

Measurements

Head, long 1.27-1.30 mm., wide 0.75

Pronotum long 0.19, wide 0.47

Mesonotum, wide 0.33

Metanotum, wide 0.47

Tibia 1, long 0.66

Affinities—The imago of *E. feldi*, n. sp. is very similar to that of *E. hastilis*

*Eutermes tumuli* Froggatt

Text-fig 14 Imago.—Wing-membrane (greatly magnified)

Text-figs 15-16 Soldier—15 Head in profile, 16 antenna, proximal segments

Froggatt (identified for me by Mr Froggatt from soldiers and workers only, collected at Stapleton, Northern Territory). It differs in having (1) the whole surface of the wing-membrane clothed rather densely with small setae (in *hastilis* the basal half of the wing is without setae excepting for a few on each of the veins; on the apical half the setae are more numerous, but not nearly so numerous as in *feldi*), (2) slightly smaller and less prominent eyes; (3) ocelli smaller and more widely separated from the eyes, (4) larger postclypeus, (5) lighter coloured mouth-parts; (6) darker sternum, and (7) larger pronotum. The soldiers of these two species differ more markedly, *hastilis* having paler head and very slender snout. The imago of *feldi* also resembles *E. tumuli* Froggatt (types compared). The wings of the latter are slightly larger and darker and the veins

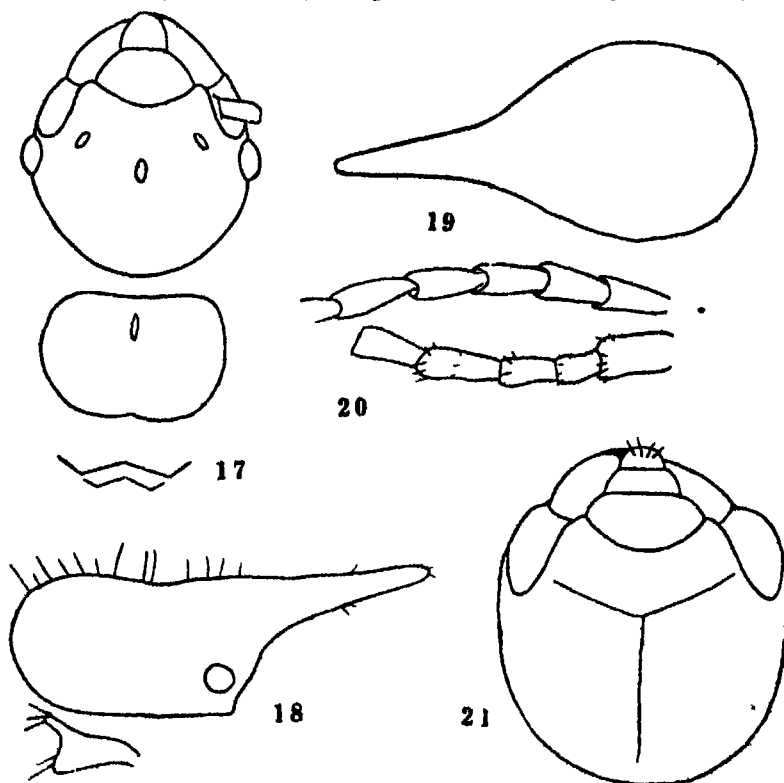
are distinct throughout their length, the eyes are larger and the wing sculpturing entirely different (compare Text-figs 10 and 14). The soldiers of *fieldi* and *tumuli* are easily differentiated by the antennae and the shape of the heads (compare Text-figs 11 and 13 with 15 and 16).

Described from a series, comprising 4 alate imagos, several nymphs and eight soldiers in alcohol, from the South Australian Museum collection. The specimens are in poor condition but are sufficiently perfect to be adequately described.

Types in the South Australian Museum; paratypes in the author's collection.
Locality—Central Australia Tennant Creek (J. F. Field, May, 1907).

EUTERMES TRIBULUS, n.sp. (Text-figs 17-21)
Queen (Text-fig. 17.)

Colour Head, thorax, wing-stumps and abdominal tergites auburn; clypeus



Eutermes tribulus, n.sp.

Text-fig 17 Imago—Head, pronotum, and posterior margin of meso- and metanotum.
Text-figs 18-20 Soldier—18 Head and pronotum in profile, 19 head from above;
20 antenna, ten proximal segments.
Text-fig 21 Worker—Head from above.

amber-brown; anteclypeus, mouth-parts, under surface and legs lighter.

Head (Text-fig 17) moderately large, setaceous, hemispherical behind the eyes, clypeo-frontal suture markedly concave, fontanelle very large, elongate-oval.

about equidistant between clypeo-frontal suture and posterior margin of head, eyes small (0.235 diam.), prominent, separated from the lower margin of the head by a space of 0.140; ocelli large, oblique, very widely separated from the eyes; clypeus moderately large, four-sevenths as long as wide, clypeal suture straight, anteclypeus very short, slightly arcuate in front; labrum about as long as clypeus, hardly covering apices of mandibles, antennae (mutilated) with 2nd joint small, less than half as long as 1st, and much narrower, 3rd very small, smallest of all, 4th and 5th rounded, equal

Thorax (Text-fig 17) Pronotum nearly as wide as head and similarly clothed, anterior margin very slightly sinuate, sides rounded to the emarginate posterior border; meso- and metanotum with posterior margin sinuate (as shown in Text-fig 17), wing-stumps of the mesonotum larger than those of the metanotum and not reaching the latter, surface setaceous, veins dark, suture straight

Legs short and moderately stout, setaceous

Abdomen. Tergites short

Measurements

Total length (about) 17.00 mm.

Head: from posterior margin to apex of labrum, long 1.50, from base to clypeo-frontal suture, long 0.90, at and including eyes, wide 1.31

Pronotum: long 0.658, wide 1.034

Tibia I., 0.94.

Soldier (Text-figs 18-20)

Colour Head and antennae uniform amber-brown, anterior margin of pronotum a little darker, thorax and legs buckthorn-brown. Head, thorax and abdomen scantily clothed with long and moderately stout setae.

Head (Text-figs 18 and 19) long and slender, snout nearly as long as remainder of head, head slightly constricted on the sides and above, antennae (Text-fig 20) 14-jointed, long and slender, 1st joint long and rather stout, 2nd about half as long as 1st and very narrow, 3rd longer than 2nd and about as wide, 4th as long as 1st, slender, 5th and 6th equal, a little shorter than 4th, 7th as long as or longer than 1st and 4th, remaining joints a little shorter than 7th

Thorax Pronotum very small, saddle-shaped, anterior half sharply bent up and darker in colour than posterior half, anterior margin fringed with long setae

Legs long and slender, clothed scantily with long setae, claws very long and slender.

Abdomen clothed with markedly long and stout setae, cerci very long and slender.

Measurements

Head: long 1.645 mm., wide 0.730

Pronotum: long 0.188; wide 0.470-0.517.

Tibia III., long 1.270

Worker (Text-fig 21)

Colour: Head mummy-brown, clypeus and mouth parts buckthorn-brown

Head (Text-fig. 21) large, broadly rounded behind, widest at the insertion of the mandibles, frontal and transverse sutures very distinct, clypeo-frontal suture markedly concave; clypeus small, not strongly convex, clypeal suture straight, anteclypeus small, straight in front; labrum small, rounded, not covering apices of the mandibles

Thorax Pronotum very small, saddle-shaped, anterior half bent up sharply, rounded in front, with deep emargination in middle, the whole surface with scattered stout setae

Measurements

Head base to apex of mandibles, long 1 645 mm , base to clypeo-frontal suture, long 1 222, wide 1 550 ;

Tibia III, long 1 410

The specimens at my disposal are in poor condition, but as all the castes are represented and the species is a very distinct one I have not hesitated to describe it as new

Described from a series comprising one true queen, one neotenic queen, about twelve soldiers and one worker, from the South Australian Museum collection

Types in the South Australian Museum, paratypes in the writer's collection

Locality -- Central Australia. Tennant Creek (J F Field)

STUDIES IN LIFE-HISTORIES OF AUSTRALIAN DIPTERA BRACHYCERA

PART I STRATIOMYIIDAE

No 4 The respiratory system in larva, pupa and imago of *Metopoma rubriceps* Macquart

By VERA IRWIN-SMITH, B Sc, F L S, Linnean Macleay Fellow of the Society in
Zoology

(Fifty Text-figures)

[Read 18th April, 1923]

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Introduction

The respiratory system of this species was dealt with very briefly in the general account of the life-history given in the first paper of the series (Irwin-Smith, 1920). The further investigation of certain structures then referred to has led to a detailed study of the whole system in larva, pupa and imago, and has resulted in the discovery of features of great interest and significance, which are probably common to the whole Stratiomyid family, although they have hitherto escaped the attention of Dipterologists. The present paper gives the results of the investigation, and forms a contribution to the important subject of the post-embryonic development and comparative morphology of the re-

spiratory system in Diptera and in insects in general, upon which it is hoped that some additional light will be thrown by the new information now presented

Historical review

Halday, as long ago as 1857, referred to the "complexity of the respiratory apparatus", superadding the series of lateral spiracles to the curious fringed bell for air which usually surrounds the posterior opening" as one of the characters which serve to make the larvae of the Stratiomyidae "about the most perfectly organised among the Diptera". But, in spite of this, all workers on the group up to the present time have confined their attention to the external features of the system, and existing descriptions consist merely of an enumeration of the spiracles or of a very brief account of their appearance and arrangement. No attempt has been made to examine the internal structure, or to follow out its development in pupa and imago.

Most writers follow Brauer (1883) in describing the larvae as either amphipneustic or peripneustic with stigmata on 1st and 3rd to 7th or 4th to 7th segments behind the head. Malloch's diagnosis (1917) of the larval characters includes the statement "lateral metathoracic and abdominal spiracles present or absent". From the study of the larva of *Metopoma rubriceps* it will be seen that this question of the presence or absence of lateral spiracles is one of considerable importance. But on this point descriptions of the same genera given by different authors frequently fail to agree. Some genera, e.g., *Paedagaster* and *Xyomma*, are generally described as amphipneustic, in other genera, e.g., *Oncera*, the metathoracic and seventh abdominal spiracles are said to be missing. But, while some observers have failed also to detect lateral spiracles in *Chloromyia*, *Microchrysa* and *Sargus*, Lundbeck (1907) says that extremely small spiracles are present on the first seven abdominal segments in these genera, though metathoracic spiracles are missing, and, from accounts given by Lundbeck and many other workers, it seems certain that the genera *Stratiomyia* and *Odontomyia* possess lateral spiracles, although Malloch says they cannot be distinguished. Both Malloch and Lundbeck, however, are of the opinion that even when lateral spiracles are undoubtedly present, they are probably not functional, and Lundbeck thinks that the prothoracic spiracles also are not in function, concluding "thus with regard to the tracheal system the larva could be termed metapneustic."

Now, a careful examination of the larva of *Metopoma rubriceps* has shown that the lateral spiracles in this species are not only functional, but are of great importance in connection with the subsequent development of pupal spiracles. Brauer, in 1883, had already stated that the Stratiomyid nymph is always peripneustic, and that the first to the sixth abdominal stigmata are bound with the corresponding stigmata of the larval skin through tracheae. If, as is most probable, the pupal spiracles are developed in all the genera in the way described here for *Metopoma*, it seems safe to conclude that the Stratiomyid larva, too, must be always peripneustic, and that, where larvae have been described as amphipneustic, the lateral spiracles have been overlooked. This view is supported by Lundbeck's statement that "the spiracles are often so indistinct and especially just on metathorax and towards the apex of abdomen, that it may be very difficult to decide their actual number."

Meijere, in his elaborate account of the stigmata of Dipterous pupae (1902), mentions the Brachycera very briefly, and devotes only a few lines to the

Stratiomyidae He refers to Brauer's statement, and expresses the decided opinion that if, as Brauer affirms, the abdominal stigmata of larva and pupa are bound together by tracheae, the pupa is not, on this account, really peripneustic, since the stigma scars of the pupa are closed "Dass durch dieselben noch einiger Luftwechsel stattfindet, glaube ich jedoch nicht, weil die zusammengefallenen Stigmennarben dieses wohl überhaupt nicht zulassen" (p 640)

My investigations have proved that Meijere was wrong in this From the description of them given in this paper, it will be seen that the pupal spiracles are highly developed structures, and are certainly open and functional

With the exception of Brauer and Meijere no one has paid any attention to them But several authors have noted papilla-like markings on Stratiomyid larvae without recognising their significance Malloch (1917) describes and figures "a small round wart just posterior to each spiracle" on abdominal segments 2-5 of *Hermetia illucens*, and, in his figure of Stratiomyid larva, *genus incertus* 1, shows very distinct papilla-like folds in the same position, though he does not mention them in the text Hart (1895) mentions "a dark dot surrounding the spiracles" on the larva of *Stratiomyia norma*, Austen, in his account of *Xylomyia maculata* (1899), says "Apparently the larva is amphipneustic On each side, however, of the first six abdominal segments, immediately behind the tumid lateral ridge, and so in the angle which each segment forms with the next, I observe a small papilla On examining the larva skin with a microscope I cannot detect an aperture in any of these papillae, but it seems in the highest degree probable that they represent stigmata which have disappeared, but were functional in the larvae of ancestors of the existing species of *Xylomyia*" Lundbeck, with reference to the same genus, observes (1907) "The larva is generally considered amphipneustic, as it has posterior and terminal spiracles, but I detected on the first seven abdominal segments very small and indistinct spiracular plates, lying on each side of the segments, somewhat inwardly to the base of the lateral bristle, these spiracles are certainly not in function The small papillae mentioned by Austen certainly have nothing to do with spiracles, such papilla-like folds are found in several larvae of Stratiomyids."

The papillae which these authors saw are undoubtedly of the same nature as papillae which have been found in the same position on the larva of *Metopoma* Their structure and development are described in detail in the present paper It is sufficient to state here that, while they are not, as Austen thought, vestigial spiracles, they are, contrary to Lundbeck's opinion, directly connected with the respiratory system It will be shown that each papilla marks the position of a pupal spiracle, and forms a protective covering for it during its development on the larva.

The spiracles of the pupa and all the other parts of the respiratory system are, so far as I am aware, described here for the first time.

Methods of study.

The study of the tracheal system in all stages has been carried out almost entirely by means of dissections, and the examination of whole specimens or of portions of them cleared and mounted in canada balsam. The cuticle, especially of the larva, is so difficult to cut that sections are usually badly fractured, and even when successfully made, they are only useful for the study of histological details of spiracular structure The tracheal vessels are not easily traced in them, and for the working out of the entire system, cleared preparations of the whole insect have proved most useful

Specimens in every available condition have been examined, moult larva skins and empty pupa cases, preparations of artificial exuvia by treatment with caustic potash, and larvae, pupae and imagines in either salt solution, alcohol, glycerine, cedar oil, clove oil or canada balsam. Most of the larvae used were fixed in hot Carl's solution (absolute alcohol 15 parts, concentrated formal 6 parts, glacial acetic acid 2 parts, distilled water 30 parts), and transferred to 70% alcohol after twenty-four hours, the integument being slit or pricked to allow the fluid to penetrate, the pupae were removed from their pupa cases before being fixed, the imagines, collected in killing bottles, were stored in 70% alcohol, or chloroformed and dissected at once in salt solution.

Useful observations were made from some of the specimens treated from three to six days in a 10% aqueous solution of caustic potash, and finally mounted in canada balsam, but the most uniformly satisfactory results were obtained from specimens dehydrated in alcohol, cleared in cedar oil (mixed with absolute alcohol in gradually increasing strengths up to the pure oil), and mounted unstained in canada balsam.

Cedar oil proved a better clearing agent than clove oil, and it was found that at all stages of development the tracheal system, the major vessels at least, showed up better in this medium than in any other tried, though for the complete elucidation of some features it was necessary to examine different specimens treated by one or other of all the various methods tried. For the examination of the finer details, the portion of the body required was removed with fine scissors or needles under a binocular dissecting microscope, and, after the necessary treatment, mounted separately in canada balsam.

All the text-figures were prepared by the writer from drawings made at stage level with the aid of a Zeiss-Abbé camera lucida and Zeiss and Reichert oculars and objectives.

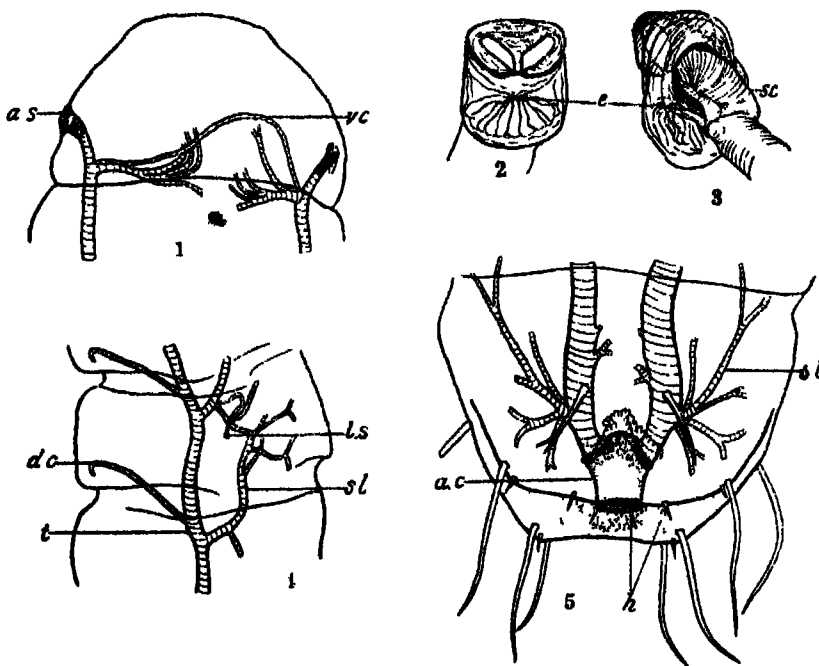
THE TRACHEAL SYSTEM OF THE LARVA

Tracheae.—There are two main tracheal trunks which lie in a dorso-lateral position and extend through the whole length of the body from the anterior spiracles to the posterior air chamber, diminishing in calibre from the posterior to the anterior end. A short arched transverse commissure connects them dorsally at the anterior border of each body segment from the second to the tenth (Text-fig. 48). The commissure for the first segment occupies a deeply ventral position (Text-fig. 1, *vc*), if there is also a dorsal commissure, it is not distinguishable among the crowd of fine tracheal branches in this region. No corresponding commissure could be detected in the eleventh segment.

Just behind the commissure in each abdominal segment, a fairly stout branch arises from the outer side of each trunk, and runs forward to junction with the corresponding branch in the next segment (Text-fig. 4, *sl*). In this way a series of closed segmental loops is formed along the sides of the body, the last loop (in the eighth abdominal segment) being formed by a large branch given off just above the posterior spiracle (Text-figs 5, 48, 57). In the third thoracic segment similar branches are given off, but they are very indistinct, and could not be traced to their connections, in the second segment, lateral branches could not be detected.

From the under side of each loop three main branches arise, which pass outward and downward to form, with their ramifications, the principal supply to the body wall and viscera. From the main trunks themselves very few branches are given off, except at the anterior and posterior ends of the body. It is these

apical regions which receive the most extensive supply of tracheae. At the anterior end, just behind the ventral commissure, a stout trachea is given off from the inner side of each trunk, which dips ventrally, and immediately divides into a cluster of radiating branches, spreading out fan-wise, and dividing into tracheoles to supply all the region of the head, pharynx and masticatory apparatus. At the posterior end, large branches are given off from the main trunks internally and externally just above the posterior spiracles, the principal external branches being formed in association with the segmental loops (Text-fig 5). The general trend of all these branches is upwards, away from the air



Text-figures 1-5 Larval respiratory system

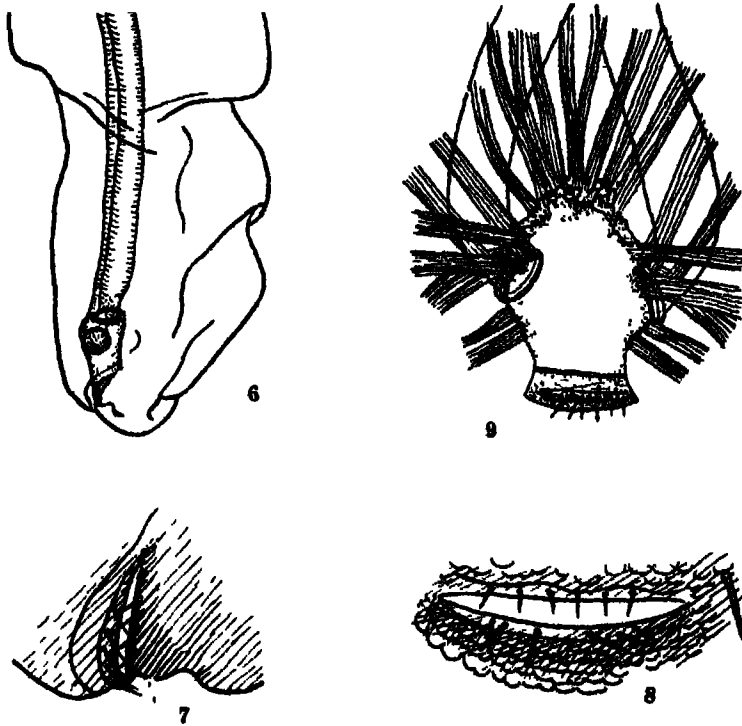
1 Spiracles and tracheae of prothorax, ventral view ($\times 40$) as, anterior spiracle and stigmatic chamber, seen from the back, vc, ventral commissure. 2 Anterior spiracle, front view ($\times 160$). 3 Back view of the same ($\times 160$) e, stigma excavation, sc, stigmatic chamber. 4 Tracheal system of abdominal segment, lateral view ($\times 25$) dc, dorsal commissure, ls, lateral spiracle, sl, lateral segmental loop, t, longitudinal tracheal trunk. 5 Termination of tracheal system at posterior end, dorsal view ($\times 40$) ac, air chamber, h, sensory hairs, sl, segmental loop.

chamber, but their finer ramifications extend in all directions through this region of the body.

The air chamber is situated dorsally behind the level of the anus (Text-fig 6). It opens by a narrow transverse slit in a deep groove which is slightly pre-apical, and, as explained in a previous paper (Irwin-Smith, 1920) is probably the dorsal incisure between the fused eleventh and twelfth body segments. In mature larvae, the aperture is 25 to .32 mm. wide. The area surrounding it is

heavily chitinised, and on each lip there is a row of very fine, short, colourless hairs, which together form a slight fringe over the opening, not sufficiently long or dense to screen it effectively (Text-figs 7, 8). The eight larger hairs, or bristles, found in association with the posterior groove are figured in Text-fig 5, *h*. They are probably of the nature of sensory hairs.

When the body is split open by a longitudinal section through the groove and aperture, the air-chamber is exposed intact, on the dorsal portion. Its walls are thin and transparent, and only show up well when stained. In mature larvae it is of relatively considerable extent, 32 to 40 mm long, and 25 to 32



Text-figures 6-9 Larval respiratory system

- 6 Lateral view of posterior end, showing aperture of air chamber ($\times 40$).
 7 Aperture ($\times 133$) 8 The same, viewed from posterior end ($\times 133$) 9.
 Longitudinal section through air chamber, dorsal side, showing muscles attached ($\times 63$)

mm in maximum width, and, by the action of numerous muscles attached to its walls, it appears to control the admission of air to the tracheal trunks. The respiratory muscles are arranged in groups, which stretch in all directions between the chamber and the body wall, some are shown in Text-fig. 9. One powerful group extends from the anterior end of the chamber to the dorsal wall; one group is inserted on the dorsal side and another on the ventral side of each spiracular opening, extending out laterally; two muscles just below the spiracle are attached ventro-laterally to the body-wall; while other muscles connect the

dorsal and ventral walls medianly with the corresponding body-walls. The points of attachment of the muscles are seen on the walls of the chamber as groups of oval brown patches. The width of the slit-like aperture of the chamber is evidently controlled also by the action of muscles.

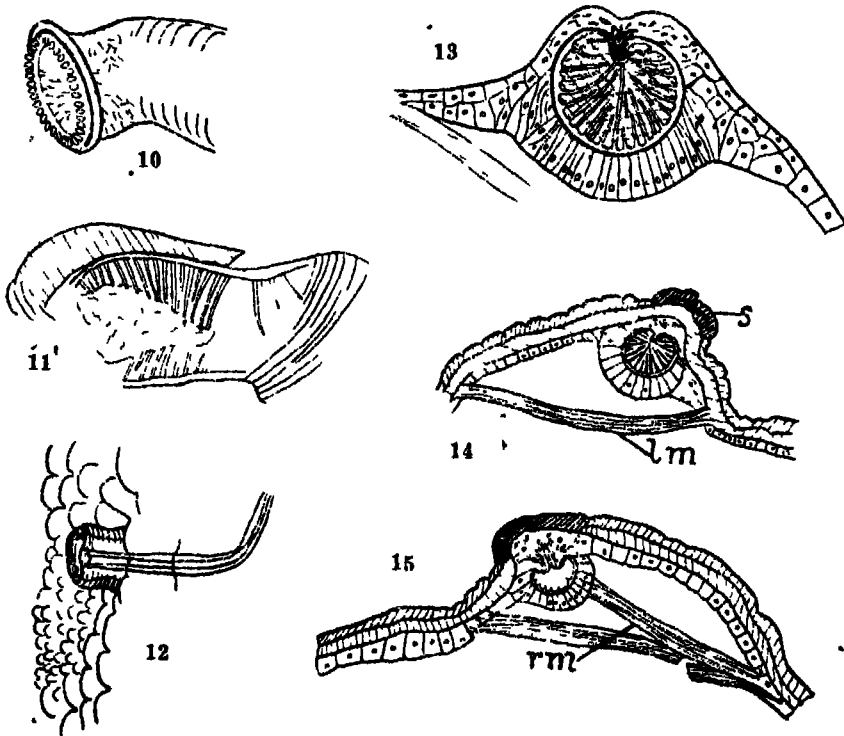
The posterior spiracles, which open anteriorly into the air chamber, have all the appearance of spiracles opening on an external surface of the body (Text-fig 10). The large open mouth of each is circular, 10 to .13 mm in diameter, with a thick, prominent rim, having a beaded ornamentation on its upper surface. The number of "beads" varies from 40 to 50. The first portion of the tracheal trunk, to a distance of .06 to .11 mm from the rim, is modified to form a sieve-chamber, being provided with a number of short, stiff, rod-like setae, which project inwards from the cuticular lining of the wall. The rods do not extend right across the lumen of the tube, but, in the sections examined, the passage between them is found to be occluded by a lump of granular material, in which the ends of the rods are embedded (Text-fig 11). This granular matter has the appearance of a foreign substance, rather than an organic part of the structure.

The anterior spiracles are present in the newly hatched larva, and retain the same form and structure throughout the whole larval life. They are many times larger than the lateral spiracles, and form conspicuous objects on the dorso-lateral margins of the prothorax. In mature larvae each measures from 100 to 150 mm in length, and from .085 to .100 mm. in maximum width, and consists of two distinct regions (Text-fig 2). The upper part, which protrudes above the surface of the integument, is disc-shaped, from .070 to .080 mm. wide, and from .040 to .055 mm. long, and is formed of very dense, dark brown chitin, with smooth upper face and even outline. It bears two large, oblique slits, .033 to .044 mm long, which converge posteriorly, and are separated by a narrow partition, incomplete at the base. Below this disc, there is a shield-shaped area of lighter brown chitin on a level with the body cuticle, with a roughened surface, having petal-like folds which converge on a narrow excavation towards its middle. The shield serves to protect the stigmatic chamber into which the two oblique slits open, since it covers exactly the area occupied by the latter.

The stigmatic chamber forms the terminal portion of the main tracheal trunk, and corresponds to the "felted-chamber" (Filzkammer) described by Meijere (1895). It is certainly functional, but in it the tracheal walls have been modified to form a complicated occluding apparatus, evidently for the exclusion of foreign matter. It is a compound, cylindrical chamber, .080 to .092 mm long, and .040 to .050 mm at its greatest diameter, where it junctions with the trachea proper (Text-fig. 3). It is filled with a mass of clear, delicate, chitin rods, embedded in an extremely fine meshwork, of which the structure is not clear, even under high magnifications. The rods are attached to the chitinous intima, and extend transversely and slightly upwards across the chamber, converging on an indentation along the upper wall, where it is slightly thickened, and covered by a mass of granular tissue (Text-fig. 13). In this a fine lumen may be detected. From the base of the chamber, in the region of this indentation, a narrow, simple tube is given off, which traverses the granular tissue, and is attached to the excavation on the chitinous shield, which constitutes the so-called "stigma scar" (Stigmenarbe) of Meijere.

This tube has been already observed in a Stratiomyid larva, *Pachygaster minutissima*, by Tragardh (1914), and in many other dipterous larvae. Meijere

considers that it is the original tracheal tube, round which the stigmatic chamber has been formed as a secondary growth, a conclusion which seems to be borne out by a study of the lateral spiracles of the *Metopoma* pupa. It will be seen, from the description given later, that these are very similar structures, and they are certainly secondary formations growing up round the primary lateral spiracles. But if this is the case with the prothoracic stigma of the larva, the original tracheal ending must be a purely embryonic structure, since the compound chamber is already present when the larva emerges from the egg. On the other hand, there is some evidence that the pronymphal opening of the anterior spiracles is formed in the position of the larval stigma scar, so that the scar may be rudimentary rather than a vestigial structure.



Text-figures 10-15 Larval respiratory system

10 Posterior spiracle (x 123) 11 Longitudinal section through posterior spiracle (x 253) 12 Lateral (abdominal) spiracle (x 387) 13 Transverse section through stigmatic chamber of anterior spiracle (x 387) 14 Transverse section through lateral body wall in region of stigmatic chamber (x 167). *l*m, lateral muscle *s*, stigmatic shield 15 Transverse section through the same, in region of junction of stigmatic chamber and trachea (x 167) *rm*, respiratory muscle

The stigmatic chamber is enclosed in a very thick layer of hypodermis, composed of a single row of long, narrow cells with large nuclei, which at the sides become continuous with the hypodermis of the body wall.

As with the posterior air-chamber, the admission of air to the prothoracic stigmata is evidently controlled by the action of respiratory muscles. Muscles are attached to the junction between the trachea and stigmatic chamber, and ex-

tend between it and the ventral body wall (Text-fig. 15). In addition, there are transverse muscular bands extending across the body in the lateral area occupied by the stigmatic chamber, which partially shut it off from the general body cavity, and, by their contractions, evidently vary its size and shape (Text-fig. 14).

Head spiracles—The occurrence of spiracles on the head of the Stratiomyid larva is not mentioned by any previous worker. But a pair of structures which have all the appearance of spiracles is certainly present in this species. They are situated ventrally at the base of the lateral "bosses," and are referred to in the first three papers of this series (Irwin-Smith, 1920, 1921). They are figured in Part I (Pl. xxvii), Part II (Text-fig. 4), and Part III (Text-fig. 13-17).

Lateral spiracles—Spiracles are present on the metathoracic and first seven abdominal segments. They are extremely small, and, under low magnification, can only be detected as a small dark spot on the border of each lateral groove, towards its anterior margin. On the mesothorax, on which they do not occur, there is, in a corresponding position, a small colourless hair. When highly magnified, the spiracles are seen to be cylindrical, chitinous structures, which project slightly (0.1 mm) above the surface of the integument, and have a diameter of 0.18 to 0.2 mm (Text-fig. 12). Each has a distinct cavity, and is connected with the central tracheal system by a fine tube, which arises from the fork junction of the segmental loops. In this tube a distinct lumen, which appears to be continuous throughout its length, is visible. As far as could be ascertained by careful microscopic examination, without the aid of serial sections, there is no "plugging" of the spiracle, nor solidification of any portion of its air tube, such as is described by Carpenter and Pollard (1918) for the *Hypoderma* larva.

It would appear, therefore, that the lateral spiracles are functional, contrary to the opinion of most workers on the Stratiomyidae. But they are so minute that they cannot play a large part in respiration, and no valvular arrangement is discernible in connection with them.

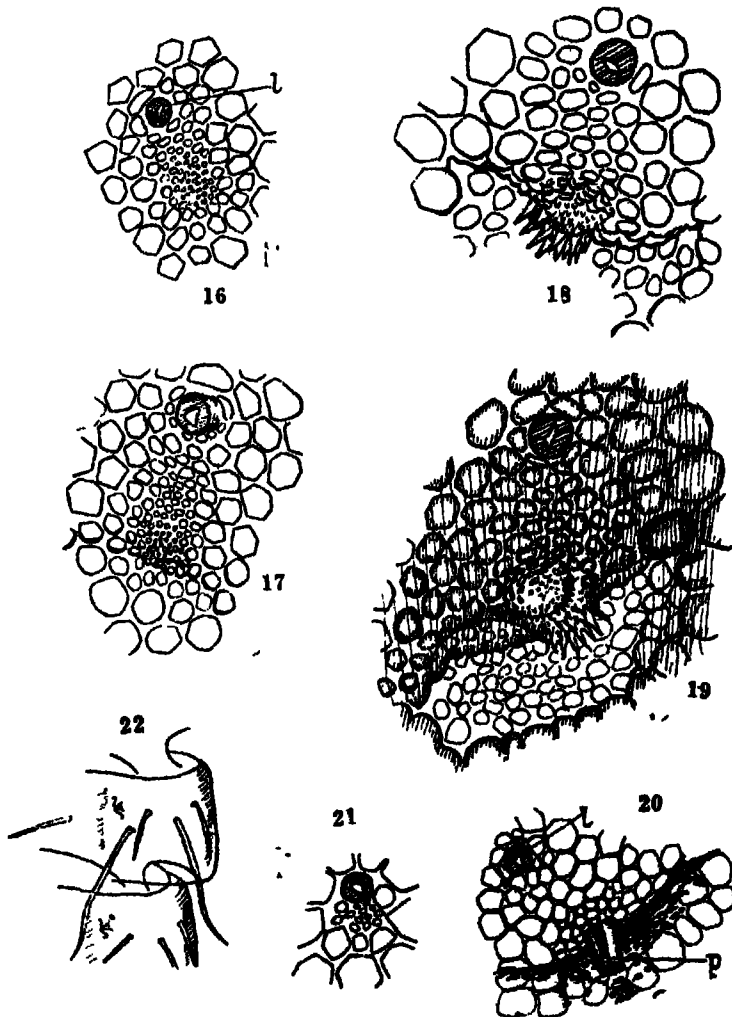
Development of secondary spiracular papillae

In the immediate vicinity of each abdominal spiracle, in the older larvae, a dark chitinous fold in the integument is plainly visible. As already stated, these structures have been observed in other Stratiomyid larvae but their true nature has not been recognised hitherto. Close investigation has now proved that they are formed in direct relation with the formation of rudimentary pupal spiracles in the larva, and that they undergo a process of continuous development throughout the whole of larval life.

When large numbers of larvae are examined it is seen that there is a marked difference in this region in larvae of different ages, but the position of the secondary formation is clearly indicated on the larval cuticle from the earliest stages of growth. Immediately behind the primary (larval) spiracles, in the young larva, the calcareous hexagonal plates are smaller than elsewhere on the body, and at a distance of .05 to .07 mm postero-dorsally from the spiracle, there is found a circular area of minute, delicate, rounded plates (Text-fig. 16). This region is found only on the segments which, in the pupa, bear the complex spiracles, i.e., the first to the sixth abdominal. On the metathoracic and seventh abdominal segments, where no change occurs, the spiracular area presents the appearance shown in Text-fig. 21, in which large hexagonal plates of the regular character occur all round the spiracle.

The next stage in the development of the secondary formation is shown in

Text-fig 17 It takes the form of a slight thickening of the plates of the circular area, and a folding over of the plates bordering it on the side remote from the spiracle, with a deposition of chitin along one side. In this way a



Text-figures 16-22, showing lateral spiracles of larva, and development of secondary papillae (16-19)

16 First stage 17 Second stage 18 Third stage 19. Fourth stage, on larva 20 The same region on puparium showing neck of pupal spiracle protruding through cuticle l, larval spiracle, p, pupal spiracle Figs. 16-17 (x 290), figs 18-19 (x 305), fig 20 (x 190) 21 Lateral spiracle of meta-thoracic segment (x 290) 22 Dorso-lateral view of abdominal segments, showing position of secondary papillae at the fourth stage (x 30)

well-defined line comes to be formed, beyond which the cuticle is slightly depressed.

At a later stage (Text-fig 18), the depression is accentuated into a definite trough, over which, on one side, the rim of chitinated plates projects. The circular area has grown out into a rounded boss, on which the plates have become modified into a rosette-like arrangement of narrow, projecting leaves and spines, while on the rim of the trough immediately behind the boss, a cluster of larger spines takes the place of the chitin plates.

At a still later stage (Text-fig 19) the whole area along the margin of the trough has become a deep brown, due to a heavy deposition of chitin, the boss has become more prominent, and the spines stouter and stronger. The trough is 10 to 13 mm. long, and the secondary formation is now much more conspicuous than the primary spiracle.

Just below this region, in larvae which are still comparatively young, the pupal spiracles can be seen in process of formation. Their development will be described later, in connection with the pupal metamorphosis. The secondary papilla is evidently a protective covering for the spiracle during its formation, and the prominent boss marks the position of the neck of the spiracle. It does not perforate the cuticle during the larval stage, and no aperture could be detected in this region in any of the larval preparations examined, but at pupation it becomes visible on the external surface. When the puparium is removed from the pupa and prepared for microscopic examination, it is found that the neck of the spiracle is now protruding through the integument, and projects for a distance of .03 to .04 mm. over the trough (Text-fig 20). The pupal spiracles, therefore, are already well developed and functional at the onset of pupation.

Details of the secondary papillae are difficult to make out on the puparium. On the living pupa it is so dry and opaque, and usually so covered with grit, that little or nothing can be seen of it. A mass of dirt fills the trough, and covers the position occupied by the spiny plates in the larva, and, even when the puparium is removed, and cleared for mounting, it is almost impossible to clean this away. But, as far as can be ascertained, the spiny formation disappears at the end of the larval period.

The different stages observed in the development of the secondary papillae apparently represent successive larval instars, and, when more information is available, they should afford a good indication of the age of the larva. At present it is not possible to determine at what age the development begins, or the length of time the larva remains in each stage. Unfortunately, the papillae, especially in the earlier stages, are most difficult to see on the living larvae; they can only be detected in strong sunlight, and after long familiarity with their appearance in microscope preparations.

Among the preserved specimens examined, most of those under 6 or 7 mm. long were still at the first stage (Text-fig 16), some larvae of 7.7 and 8.3 mm. lengths were at the second stage (Text-fig 17), while others of 7.8 and 8.0 mm. were at the third stage (Text-fig. 18), others, again, of 8.3 mm. were at the fourth stage (Text-fig. 19), as were all those over a length of 8.5 mm.

Seven larvae between 8 and 10 mm. long, which were collected in the field on November 4th, were already at the fourth stage, the shorter and more slender specimens being evidently males. They were kept alive, but went through the whole spring season without pupating, and are still active larvae (February 1st, 1923). [See also postscript, p. 81.]

As it has been proved that the imagines only appear twice a year, in.

November and April, it is evident that they cannot pupate now before April at the earliest, so that the fourth stage must occupy at least six months.

PUPAL METAMORPHOSIS

Lowne (1892) recognises three distinct stages in the pupal development of the blowfly, to which he gives the names pronymph, nymph and proimago. He distinguishes as the pronymph the stage at which the head and thoracic appendages are still invaginated, and the larval organs are undergoing histolysis, after the shedding of the larval skin to form the puparium and the enclosure of the body in a temporary membrane, the paraderm. He considers that the nymph takes the place of the pronymph when the limbs and head are evaginated and the paraderm has been replaced by the pupal ectoderm, and applies the term proimago to the pupa from the period at which the pupal ectoderm is separated as the pupal sheath, to the escape from the puparium. He says "The changes which occur before the formation of the pupa sheath correspond nearly with those which take place in the caterpillar before the ecdysis of the last larval skin, whilst those which occur after its formation correspond with the changes which take place in the chrysalis, or nymph stage of the Lepidoptera." And he speaks of the tracheal system as it exists before "this period of virtual ecdysis," i.e., the separation of the pupa sheath, as the tracheal system of the nymph, and the new tracheal system which is subsequently formed, as the tracheal system of the proimago.

Although the larval organs of the *Stratiomyidae* do not undergo the complete histolysis which is found in the *Cyclorhapha*, the method of pupation in this family corresponds more closely with that of the *Cyclorhapha* than does that of any other of the Brachycera. The same number of cuticular skins is found covering the ripe pupa, viz., pupa case, pupa sheath and epidermis of the imago, representing three distinct ecdyses, so that Lowne's three stages are clearly recognisable in the pupal period, and, for convenience, his terms can be applied to the different stages of tracheal development.

The majority of the pupae of *Metopoma rubriceps* examined were already in the proimago stage, a few were obtained in the nymph stage, and one, only, at the pronymph stage. This last specimen I had the good fortune to find just after it had been attacked and killed by a fungal growth which had extended all over the tracheal system. The other tissues had already begun to decay, but the entire tracheal system, to its smaller ramifications, was revealed in dark outline by the fungus with the clarity of an injected blood-vascular system. It is figured in Text-figs 23, 27, 49. It is apparently at a late period in pronymphal development. The legs are already exposed, but the head is still invaginated, and the cavity at the anterior end, within which it is withdrawn, contains the exuviated pharynx and masticatory apparatus of the larva. The pupa sheath is not yet formed, and the body is still covered by an integument, the external layer of which consists of a thin, transparent cuticle. Whether this integument is the "paraderm" of Lowne, or the pupal ectoderm, there is not sufficient evidence to prove, the tissues are in too decayed a state for detailed histological examination. But the tissue immediately below the integument is in an attenuated condition, and the body of the nymph is becoming vaguely outlined at a lower level, although it is not yet delimited by a definite cell wall. The cuticular intima of the rectum of the larva has been expelled, but remains attached externally to the body in the position of the larval anus, and the exuviae of the terminal portions

of all the larval tracheae which open on the surface by spiracles are found similarly attached externally to the pronymph in the position of the larval spiracles (Text-fig 23). The expulsion of these exuviae may be coincident with the separation of the larval ectoderm to form the puparium, but it is possible that they represent a later ecdysis.

The exact time occupied by the different stages of pupal development in the Stratiomyidae is exceedingly difficult to determine, since the onset of pupation is not marked by any change in outward form of the larva, and larvae of the type of *Metopoma rubriceps* are normally so sluggish that immobility does not attract any special attention.

The larva found in the pronymph stage was last observed in movement on October 26th, and its immobility was first noticed on November 13th, when it was dissected, and, as already stated, found to be dead.

In the case of the blowfly, Lowne, while explaining that the rate of development depends largely on temperature, estimates that the formation of the pronymph from the larva occupies approximately about three days, that the head is evaginated about the fourth day, and that the nymph is completely formed by the end of the fifth day. The stage of development reached by the pronymph of *Metopoma rubriceps* described here would correspond, according to this calculation, with that of a blowfly pupa three days old.

THE TRACHEAL SYSTEM OF THE PRONYMPH

Unlike the Cyclorrhapha, the tracheal system of the adult *Metopoma rubriceps* is not formed independently, but in direct relation with that of the larva. The larval vessels do not disintegrate, but remain functional at the metamorphosis, and persist to form the foundation of the pupal vessels. Although modified by the histolysis of some portions and the change in size and relative importance of others, and by the great increase in number and extent of smaller branches, the general plan of the larval system is still clearly distinguishable, and can be traced through all subsequent stages to the adult fly.

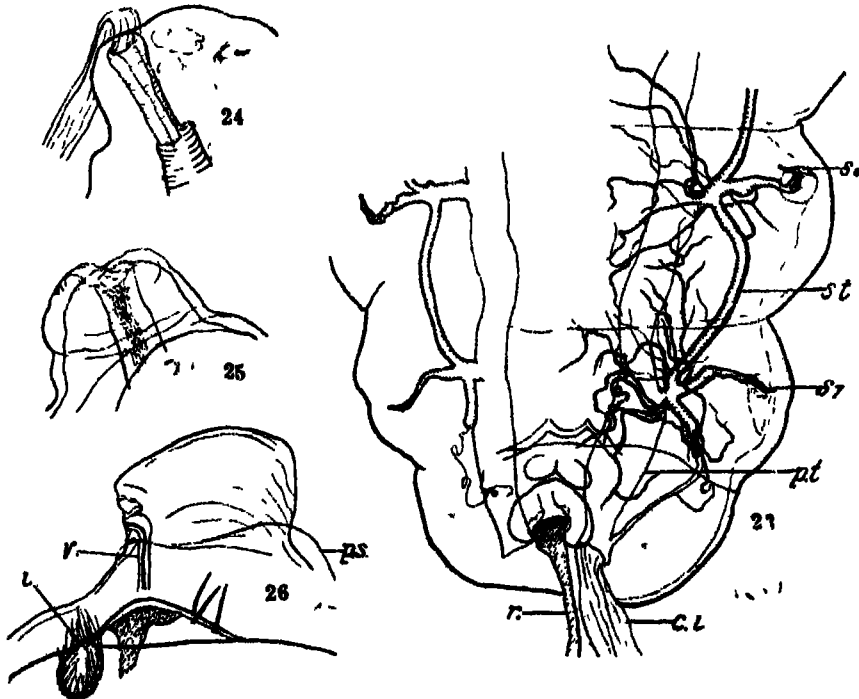
In the pronymph the two great longitudinal trunks are functional only to the fourth abdominal segment (Text-fig 49). Behind this they still retain the form of open vessels, extending down to the position of the old larval posterior spiracles, but they are much degenerated and their cuticular lining has been detached and expelled from the body in the region of the spiracles. Towards their posterior end they are already quite vestigial, and their outlines and the outlines of the posterior spiracles are only faintly discernible.

On the outer and lower side of each primary (i.e., larval) trunk, a secondary main longitudinal trunk has been formed by the straightening and enlargement of the vessels which formed the segmental lateral loops in the larva, and the ends of the loops, where they connected with the primary trunk, have now become stout commissures, from which a cluster of fine tracheoles arises in each segment. Posterior to the fourth abdominal segment, where the primary trunks are degenerating, the ends of the commissures attached to them are also beginning to degenerate, and show a distinct line of demarcation between persistent and vestigial portions. On these commissures, of the fifth, sixth, and seventh abdominal segments, the clusters of tracheoles are more voluminous than they are further forward, and ramify closely through the body tissues in the region between the two trunks. In the eighth segment, only the anterior portion of the segmental lateral

loop persists, the remaining portion, which junctioned with the primary trunk of the larva near the opening of the posterior spiracle, has degenerated completely, and only the faintest trace of it can be seen. The persistent remnant ends blindly in a thickened knob-like end, from which fine tracheoles radiate in all directions (Text-fig 23)

It is in this *posterior region* that the most marked difference is found between the tracheal systems of larva and pupa. The tracheation has become entirely recentralised. The larval system of vessels, spreading upwards and outwards from the region of the air sac and posterior spiracles, has completely disappeared, and a new system of fine tracheoles has arisen, based on the stump like ends of the secondary longitudinal trunks in the region of the small lateral spiracles of the seventh segment.

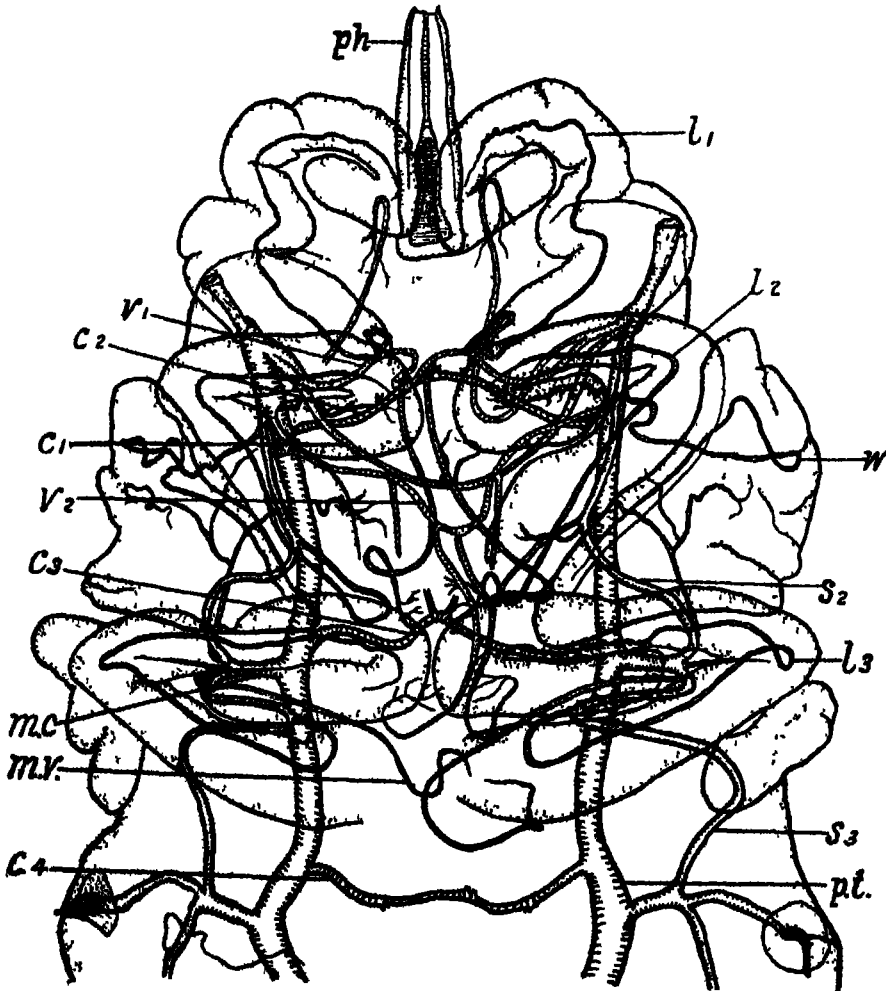
There is an increase of the number of delicate side branches supplying the body tissues in each segment, but, as in the case of the larva, these are formed entirely in connection with the secondary longitudinal trunks. The primary trunks are still almost devoid of branches. The dorsal transverse commissures,



Text-figures 23-26. Pupal respiratory system.

23 Ventral view of posterior end of pronymph, showing termination of tracheal system ($\times 42$). (On the left side of the figure only the main framework of the system is shown) c1, expelled cuticula intima of primary longitudinal trunk pt, vestigial primary trunk, r, expelled cuticula intima of larval rectum, st, segmental loop, forming portion of secondary longitudinal trunk. s6, sixth abdominal spiracle. s7, seventh abdominal spiracle. 24. Anterior spiracle of pronymph ($\times 100$). 25 Anterior spiracle of nymph ($\times 100$). 26. Anterior spiracle of proumago, showing as a vestigial structure (v) in the pupa sheath (ps), above the fully formed imaginal spiracle (i) ($\times 100$).

which in the larva, connected the two trunks in each segment, are still found in the thoracic and first to fourth abdominal segments, but behind this they have disappeared, evidently in relation with the disintegration of the trunks themselves in this region (Text-fig 49). A pair of delicate branches is given off anteriorly from the mid-region of each transverse commissure, and at least one pair anteriorly and one pair posteriorly towards the sides of the commissure. These branches do not show up clearly, and cannot be followed to their terminations.



Text-figure 27. Respiratory system of pronymph

Ventral view of anterior end, showing the principal tracheal vessels (x 57). C1, C2, C3, dorsal transverse commissures of the three thoracic segments; C4, dorsal commissure of the first abdominal segment; l_1 , l_2 , l_3 , vessels to the legs of corresponding thoracic segments; mc, metathoracic lateral commissure; mv, metathoracic ventral vessel; ph, exuviated pharynx of larva; pt, primary longitudinal trunk; S2, S3, lateral segmental loops of meso- and metathorax; V1, V2, first and second ventral transverse commissures; w, vessel to wing.

The very fine tube which, in the larva, extends out from the fork of the lateral segmental loop in each abdominal segment to the corresponding lateral spiracle, has given place to a stout branch in the same position, and the secondary lateral spiracles are already well formed and functional. The development and structure of these spiracles are of sufficient importance to require special consideration, and they will be described later in a separate section. In the seventh segment the spiracles are simpler in form, but they too are connected with the secondary longitudinal trunks by a stout branch on each side (Text-fig 23, S7).

The tracheal system of the thoracic region is much complicated and confused by the supply of tracheae to the invaginated head, but, with a little care, the system which supplies the thorax and its appendages can be distinguished and followed out.

In the larva, the course of the lateral segmental loops of this region could not be traced. In the pronymph, closed loops are formed in the second and third segments, but in each case the loops bend abruptly inwards, across the course of the primary tracheal trunks (Text-fig 27, S2, 3). From the inward bend in the second segment the secondary trunk runs forward below and parallel with the primary trunk, and junctions with it just in front of the transverse commissure of the mesothorax. A branch is given off from the inward apex of the loop in both meso- and meta-thorax to supply the corresponding leg (12, 3). The branches for the two prothoracic legs are given off anteriorly from a transverse commissure which connects the two primary trunks ventrally behind the prothoracic spiracles (11). The main branch for the wing on each side arises in the region of the junction of primary and secondary trunks (*). The short branch in which it originates forks into two, one passing directly outwards to the wing, the other directly inwards to supply with its branches the dorsal surface of the mesothorax.

Behind this, just in front of the fork junction of meso- and meta-thoracic lateral loops, a dorsal branch is given off from the outer side of the mesothoracic loop, which also supplies the dorsal area of the mesothorax, and gives off two slender branches which extend outward towards the wing. From the fork of the metathoracic lateral commissure (*m.c.*) an extremely fine tracheole extends outward, apparently to the metathoracic spiracle, but this, if present, is too small and inconspicuous to be detected. Just behind the metathoracic commissure a long branch arises from the metathoracic lateral loop and extends inward, ventrally, to supply the mid-ventral region of the metathorax (*m.v.*)

The dorsal transverse commissures connecting the primary trunks in the meso- and metathorax are quite similar to those of the abdominal segments, and, like them, are arched forward (C 2, 3). But the transverse commissure of the prothorax is bent backwards, behind and below the mesothoracic commissure, being drawn inward, evidently, with the invaginated head (C 1). It gives off a pair of short stout branches which extend posteriorly apparently to the region of the optic discs, but it is not possible to determine exactly what internal organs are supplied by the various tracheae, since their structure is not at all clear in this specimen. A much finer pair of tracheoles arises close together from the same commissure in the midline, between the stout pair, and extends anteriorly a short distance.

In addition to the three dorsal transverse commissures, two ventral transverse commissures are found in the thorax. The first is that which gives off the

pair of tracheae supplying the prothoracic legs. It junctions with the primary trunks at the point of origin of the first dorsal commissure, and appears to be identical with the ventral commissure which was observed in the larva (Text-fig 1). The cluster of radiating branches arising at its root, in the larva, is represented, in the pronymph, only by some short degenerating stumps attached to the base of the dorsal commissure on each side, and by a long branch which extends up into the larval head-plate and pharynx. This, too, appears to be disintegrating, and on one side it has already lost its connection with the primary trunk.

Two long branches are given off posteriorly from the commissure, between the pan to the legs. They extend back into the mesothorax, and terminate in its mid-ventral region in a cluster of fine threads on a rounded structure just behind the optic disc, apparently a nerve ganglion.

The second ventral commissure (V 2) is formed in connection, not with the primary but with the secondary trunks. It is attached to each mesothoracic lateral loop a short distance behind the junction of the latter with the primary trunk. It is bent sharply backward, and gives off posteriorly, from its middle, a pair of long branches which extend into the mid-ventral region of the mesothorax, and end in fine threads attached to a large oval ganglion, situated immediately behind that supplied by the pair of branches from the first ventral commissure.

The anterior spiracles are simple orifices which open directly into the tracheal trunks, without the intervention of vestibule or stigmatic chamber (Text fig 24). The prothoracic stigmatic plate and complicated stigmatic apparatus of the larva are shed with the larval skin which forms the pupa case and the new aperture appears to be formed just below the position of the larval aperture, in relation with a new terminal portion of the tracheal trunk. A scar on the integument immediately in front of the present spiracle seems to represent the position of the larval opening, and there is some evidence of a faintly outlined vestigial vessel connecting this with the tracheal trunk, but none of these structures are well defined, this portion of the body wall being in poor condition. A mass of granular tissue surrounding the new trunk probably indicates the imaginal disc from which it has been formed, and corresponds with the disc described by Lowne as the dorsal prothoracic imaginal disc. The shed lining of the trunk from a previous ecdysis is still attached externally to the stigmatic opening.

Although the new opening is situated behind the position of the larval opening, it is certainly prothoracic, and not intersegmental. It would appear that the terminal portion of the pronymphal tracheal trunk occupies the same position as the small vessel given off from the base of the stigmatic chamber in the larva, and it may be formed in direct relation with this, as was pointed out in the discussion of the larval prothoracic spiracles.

The whole structure seems to be very poorly developed, and of little importance for respiration at this stage.

THE TRACHEAL SYSTEM OF THE NYMPH

Two specimens of an early nymphal stage have been examined, the first with the head only half everted, the second (figured in part 1 of this series, Irwin-Smith, 1920, Plate 27, figs 3, 4) with head fully exposed, but with the optic stalks passing back through the neck to retinal discs which are still partially enclosed within the thorax.

The first is only slightly more advanced in development than the pronymph described above, and probably corresponds to the fourth day stage of Lowne's blowfly pupa. The shed lining of the larval rectum is still attached externally to the integument, but there is now no trace of the shed tracheal endings of the larva. The pupa sheath is not yet separated off, but the abdominal spiracles are now entirely on the surface and form prominent projections on the body wall. The two prothoracic spiracles also project slightly, the portion of the body wall surrounding them being raised into a rounded protuberance on each side of the neck (Text-fig 25) but the protuberances are quite soft, without any strengthening of horny chitinous tissue.

In the second specimen two distinct layers of integument are visible covering the body, but the outer one is still closely applied to the inner and does not form a separated sheath. All trace of larval rectum and posterior larval spiracles has disappeared, and the external apertures of alimentary canal and tracheal system are now entirely pupal in character. Unfortunately the definition of the tracheal system in this specimen is not as clear as in the pronymph, and only some of the more prominent features are visible. These have just the same form as in the pronymph, but the main trunks and branches have become enlarged and thickened, and there appears to be some increase in the number of finer branches. The protuberances on which the prothoracic spiracles are situated have become more prominent, but they are still quite soft, and the spiracles are not provided with a horny cornu, or a digitate ornamentation, and appear to be only vestigial structures. Unlike the abdominal spiracles they are not, apparently, in communication with the external air through the pupa case, and it is uncertain whether they possess a lumen at this stage. Metathoracic spiracles, if present, are still quite unimportant, for neither their apertures, nor tracheal branches leading to them can be detected. On the other hand, the abdominal spiracles are highly developed, and of complicated character. Their development and structure can now be dealt with in detail.

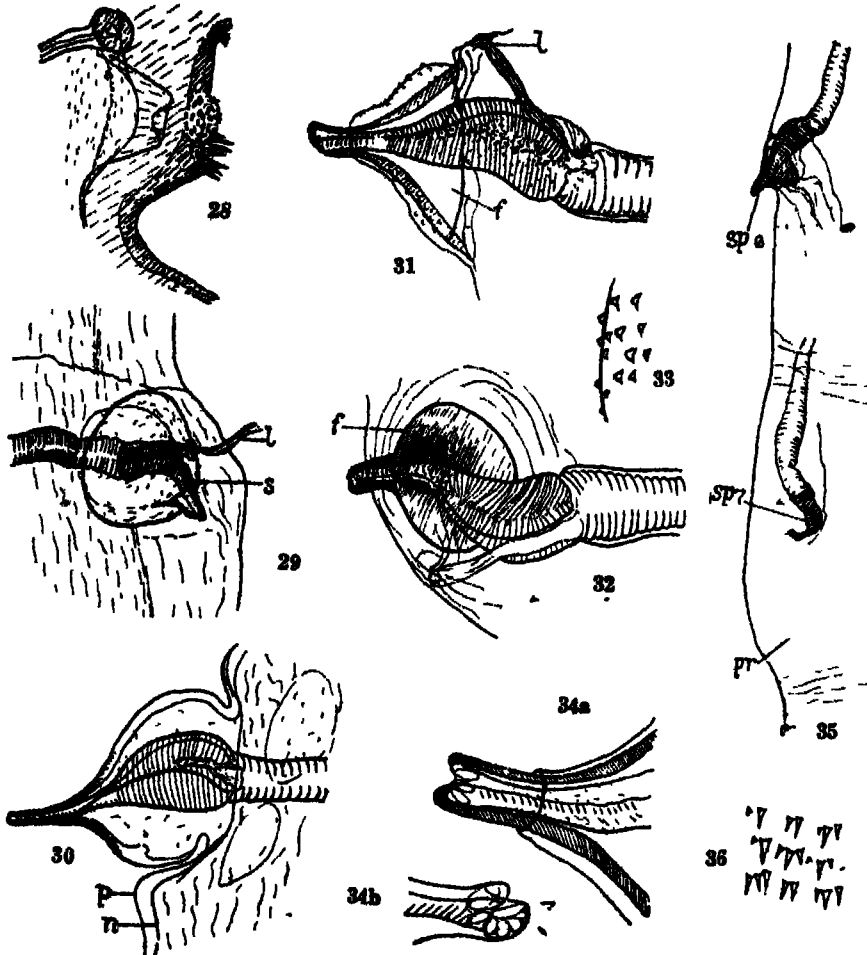
Development of the secondary abdominal spiracles of the pupa

As has been already stated, the development of the pupal spiracles begins in the larva some considerable time before pupation, and is marked in successive larval instars by changes in the form of the larval skin immediately above the developing spiracles.

Satisfactory sections could not be obtained through this region owing to the coarse, tough, spiny nature of the cuticle, and the heavy deposition of chitin, so that it has not been possible to follow out, in histological detail, the earlier processes in their formation. But some of the structure underlying the cuticle can be made out in well cleared fragments dissected from the body of the larva.

In the earlier stages, a mass of granular cells is visible in the vicinity of the primary larval spiracle, and at the fourth larval stage, represented by Text-fig 19, this region has developed into the form of a cone having a blunt, inverted top, which projects up immediately below the spiny ridge on the cuticle, to one side of the primary spiracle (Text-fig 28). It seems safe, then, to assume that the pupal spiracle is developed in the normal way, as an invagination in an imaginal disc, which adjoins or surrounds the termination of the primary larval trachea. Its horny tip must be everted when the larval skin is shed to form the pupa case, for it is found penetrating the case at the onset of pupation, and is then already open and functional.

In the pronymph (in which the head is still invaginated), the whole lateral stigmatic apparatus of each abdominal segment from the first to the sixth, with



Text-figures 28-36. Development of abdominal spiracles of the pupa

28 Optical section through region of spiracle and fourth stage papilla of larva (x 290). 29 Spiracle of pronymph (x 140) l, shed lining of larval spiracle, s, secondary spiracle developing in encapsuled disc 30 Spiracle of early nymph stage, projecting above surface of body, p, integument of pronymph n, integument of nymph (x 125) 31 Fully developed spiracle, in pupa sheath of promago (x 140) f, chitinous funnel, l, larval stigma 32 The same, viewed from the inner side (x 140) 33 Knobby processes on skin over funnel (x 475) 34a, 34b, Two views of spiracular orifice. (x 290) 35 Portion of pupa sheath removed from puparium, with spiracles still attached (x 48) sp 6, sp 7, spiracles of sixth and seventh abdominal segments, pr, processes on pupa sheath 36. The same processes. (x 475).

its surrounding disc, is found enclosed in a definite membranous capsule, deeply embedded in the somewhat attenuated tissue at the side of the body, and covered

by the integument, through which the horny tip of the pupal spiracle projects (Text-fig 37). The portion of the trachea which enters the capsule is differentiated from the extra capsular portion by a slight constriction, and an apparent difference in composition. Within the capsule the stigmatic chamber of the pupal spiracle is seen in process of formation in the middle of the disc, and appears clearly as a secondary formation growing up round the terminal portion of the primary larval trachea (Text-fig 29). It is still quite small, its maximum diameter no greater than that of the trachea where it enters the capsule. The terminal portion of the larval trachea persists as a delicate, thin-walled tube given off from its base, communicating with the larval spiracle on the integument, to the external surface of which its shed lining is still attached. It is apparently reformed after the ecdysis, and persists, and, as far as can be ascertained, remains open throughout the whole pupal period.

In the early nymphal period, when the head is just evaginated, the body is delimited by a new wall at a lower level than the old integument, and in the same plane as the base of the stigmatic capsules. The pronymphal integument is at first drawn back to this wall and is closely adherent to it. At this stage (Text-fig 30) the stigmatic capsules appear as prominent projections on the surface of the body, but they are still covered by the old integument (*p*), which is strengthened by a deposition of chitin in the region surrounding the elongated neck of the spiracle, and forms a collar for it. The stigmatic chamber has now widened out to its characteristic pear shape, and the whole capsule has become much larger.

Later the old integument is shed to form a distinct pupa sheath separated from the body by a considerable space. In this space the lateral spiracles come to lie, as already explained (Irwin-Smith, 1920), entirely *outside* the body, each connected with it only by the tracheal vessel which supplies it, and attached to the pupa sheath and pupa case (old larval skin) by the neck, which penetrates through them to the external surface (Text figs 31 and 38).

As the nymph develops into the pronymph, a septum is formed in the wall of the connecting trachea, below the surface of the body. This is strengthened by a chitinous rim, and eventually forms the vestibule of the imaginal spiracle. When the adult fly emerges, the trachea which connects the pupal spiracle with the body is severed at this point, and the whole spiracular apparatus is left behind in the pupa sheath, enclosed in the pupa case. If the sheath is pulled away from the puparium the spiracles are withdrawn from the perforations in the walls of the latter, and remain in position in the sheath, with the neck of each protruding through its protecting chitinous collar (Text-fig 35). It is in this position, in the thin transparent sheath, removed from the puparium, that the structure of the fully developed spiracle can be studied most easily.

Secondary spiracles of the pupa. When completely developed, the pupal spiracles have the form shown in Text-figs 31, 32.

Each is a large flask-shaped body, with an elongated slender neck, through which it opens on the outer surface of the puparium. The neck is stiff and horny and dark yellowish brown in colour, being highly chitinised. The stigmatic chamber into which it leads, opens at its base into the trachea connecting it with the body of the pupa. From the base a narrow delicate tube extends out to an aperture in the pupa sheath corresponding in position with the primary lateral spiracle of the larva. As already stated, this is the vestigial larval trachea, round which the pupal stigmatic chamber has developed. Evidence of

the manner of its growth is seen in the shape of the chamber. Its walls form two enveloping flaps, partially sheathing the primary trachea throughout the greater part of its length. The deep groove or crevice in it, which is formed in this way, extends right up the chamber and along the neck to the orifice, so that it is open on one side, the side nearest to the larval spiracle.

The structure of the aperture is shown in Text-figs 31a, 34b. Some half dozen wedge-shaped ribs of the chitinous wall project into the opening, between oval perforations. The floor of the neck, from the orifice to the stigmatic chamber, bears a row of fine, stiff hairs, which slant uniformly upwards and outwards towards the opening.

The stigmatic chamber was described erroneously in my first paper (1920) as having muscular walls. More careful examination shows a structure very similar in appearance to the prothoracic stigmatic chamber of the larva, in which the interior of the chamber is filled with a mass of chitin rods. I have not been able to section it, but from surface view under high magnification the rods are plainly visible, embedded in a kind of matrix composed of what appears to be a fine reticulum.

Measurements of the pupal stigmata are — Total length from base of chamber to tip of neck 240 to 250 μ m, length of neck 080 to 092 μ m, diameter across neck 025 μ m, diameter across base of chamber 062 to 077 μ m, length of primary larval trachea from junction with stigmatic chamber 129 to 148 μ m.

The chitinous collar for the neck spreads out widely below to form the protecting "funnel," 085 μ m in depth and 148 μ m in maximum diameter, which covers the upper part of the stigmatic chamber (Text-fig 32, f). Above the funnel, the surface layer of the thin pupa sheath is studded with numerous small knobby processes, which seem designed to afford the chamber still further protection (Text-fig 33).

THE TRACHEAL SYSTEM OF THE PRO-IMAGO

At the latest *nymphal stage*, the pupa sheath exists as a separate envelope only over the head and thorax and their appendages. A reddish-brown pigment is appearing in the eyes, the legs have untolded and extend down over the abdomen, and the separate segments of legs and antennae and the articulations between them are well defined, but the segments are all quite colourless, integumental hairs are faintly visible, and the pads and claws of the tarsi are forming. The abdomen is much less advanced in development and does not show any trace of integumental hairs or setae.

The tracheal system at this stage is very difficult to trace, but appears still to retain the early nymphal form. Metathoracic spiracles are not visible, but the prothoracic spiracular humps are still protuberant, and the lateral abdominal spiracles are as described for the nymph stage.

The development of the *proimago* must proceed rapidly after the entire separation of the pupa sheath, for all the pupae examined at a stage subsequent to this are well advanced, and differ but little in external form from the imago. A pupa at this stage is figured in Part 1 of this series (Irwin-Smith, 1920, Pl 27, fig. 6).

The chitinous exoskeleton of the imago is well developed, and deeply pigmented, the body segments have the form found in the adult fly, and the com-

plete ornamentation of integumental spines and hairs is present. An ornamentation of minute spiny processes is found also on the cast pupa sheath, in the form of a rectangular patch on the lateral margins of each segment a little below the spiracles. The processes are arranged in groups of twos or threes in fairly even rows (Text-figs 35, 36), and are similar to the processes found in a corresponding position on the body of the imago, but no other imaginal hairs or setae are repeated on the pupa sheath*.

The tracheal system of the pronymph is quite imaginal in character. It is already strongly developed, has become very voluminous, and is quite conspicuous in cleared specimens, except where the more deeply pigmented portions of the exoskeleton of head and thorax obscure its finer ramifications.

The most notable difference from the system in the nymph is found in the formation of large *posterior thoracic spiracles* and the development of an extensive system of large tracheal trunks in connection with them, so that this region becomes the principal source of air supply to the imago. The anterior thoracic spiracles of the imago are also fully developed, and the tracheal system with which they communicate has become greatly enlarged.

The *anterior spiracles* are situated in the antero-lateral region of the thorax, on a level with the surface of the body. The prominent spiracular humps of the nymph have been separated from the body, and show only as vestigial structures in the pupa sheath, with a faint trace of a shed tracheal tube attached to the lower border of each, immediately above the imaginal spiracle (Text-fig 26). There seems to be no doubt that the thoracic spiracles of the imago are formed in direct relation with those of the larva, and that they are, therefore, definitely prothoracic and metathoracic in origin. The large tracheal trunk, into which each posterior spiracle opens, connects it with the primary and secondary longitudinal trunks in the exact position of the fine branch which, in the larva and pronymph, communicates with the metathoracic spiracle.

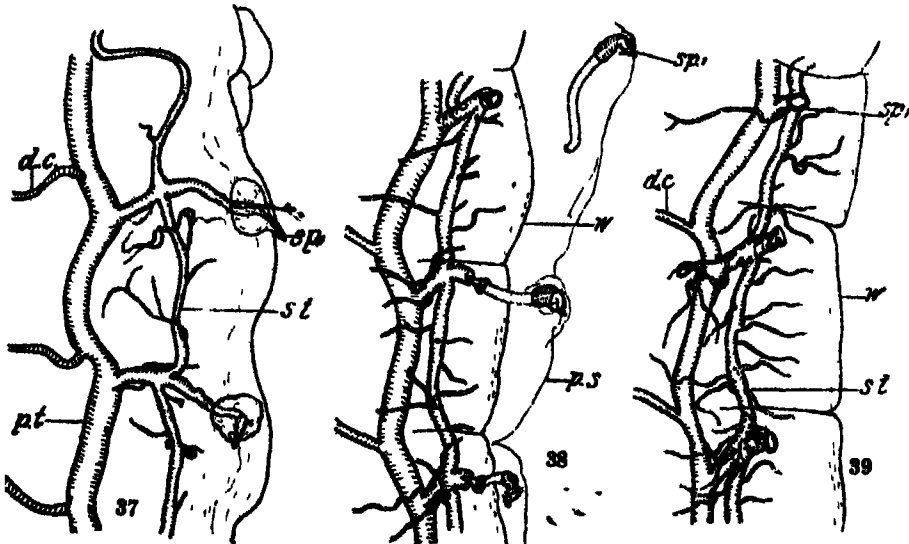
The *pupal abdominal spiracles* of the pronymph have been described already. The corresponding imaginal spiracles are now well developed, and the tracheae which connect them with the pupal spiracles are very lightly attached, so that they are easily broken away when the pupa is being handled (Text-fig 38).

The *tracheal system* still shows the same general groundplan as in the pronymph, and in the abdomen it is very little altered. The two main longitudinal trunks, primary and secondary, are still present on each side. The secondary trunks have increased in importance and give off numerous side branches all along their course, but especially in the region of the commissures which connect them with the spiracles and the primary trunks. These commissures are now wide vessels. The primary trunks remain simple and practically unbranched. Transverse commissures connecting the two primary trunks are present only in the second, third, and fourth abdominal segments. The commissure of the first abdominal segment, and the metathoracic commissure seem to have disappeared. I could find no trace of either in the pronymphs and imagines examined. The primary trunks narrow abruptly just behind the fourth spiracles, and in the segments behind these are represented only by a delicate loop tube on each side,

*This ornamentation of the sheath recalls that found on the first moult skin shed by the larva at hatching which was described and figured in Part II. of this series (Irwin-Smith, 1921, fig 2). The processes on the pupa sheath are, naturally, larger, but are of much the same form.

connecting the commissures from the secondary trunks (Text-fig. 50). The secondary trunks terminate abruptly in the seventh segment in a tuft of fine branches extending down into the tail region.

In the thorax, the original plan is greatly obscured by the extensive development of secondary tracheae; but the large simple primary trunks are still present, communicating with the anterior thoracic spiracles. They are evidently the "paragastric trunks" described by Lowne. In place of the secondary trunks there is a thick bundle of fine tracheoles on each side. But in this and all other details the thoracic system is quite similar to that of the imago, and will be described at greater length in the description of the latter.



Text-figures 37-39 Lateral abdominal region, showing development of imaginal tracheal system from pupal system

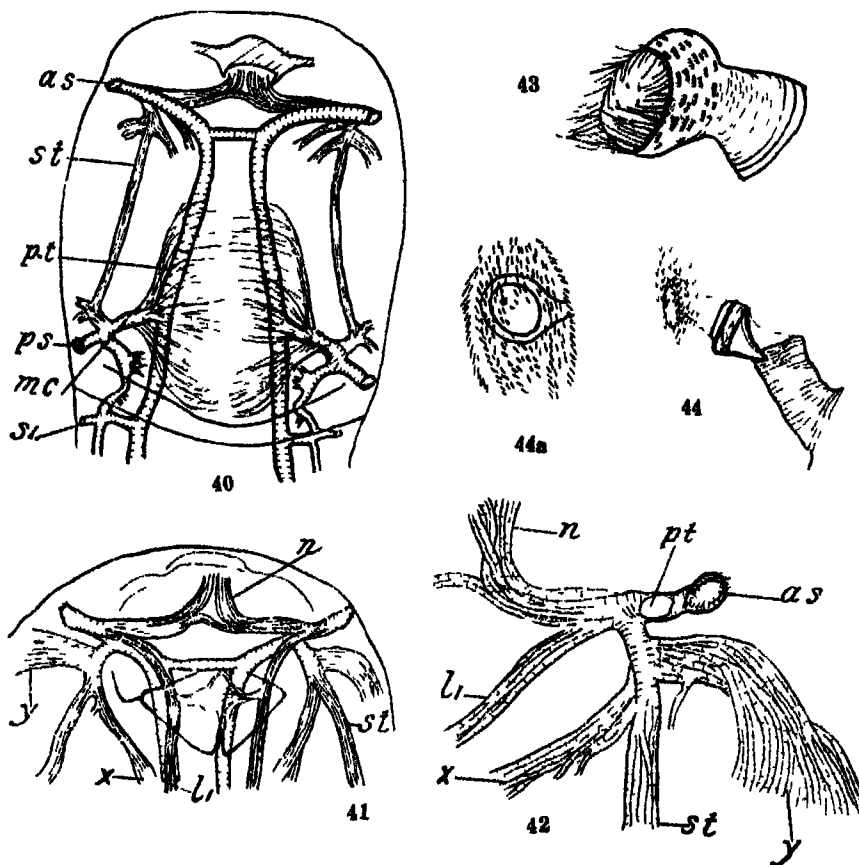
37, Pronymph, first two abdominal segments (x 48) 38 Promago, first three segments (x 43) 39 Imago, the same segments (x 43) dc, dorsal transverse commissure, ps, pupa sheath, pt, primary longitudinal trunk, st, secondary longitudinal trunk, sp 1, first abdominal spiracle (In the pronymph, the tracheal connection between the pupal and imaginal spiracles has been broken), w, body wall of imago

THE TRACHEAL SYSTEM OF THE IMAGO

The anterior thoracic spiracles are large oval openings, each bordered by a chitinous rim, which is fringed by long, close-set, dark hairs (Text-fig. 43). The vestibule into which it leads is a rounded chamber having on its inner surface numerous short setae arranged in comb-like groups with thickened, chitinous bases. It communicates with the trachea proper through a narrow neck, which apparently acts as a valve. No other valvular apparatus is discernible.

The posterior thoracic spiracles, which are situated slightly below and in

front of the bases of the halteres, are also large openings, very similar in structure to the anterior spiracles, but the comb-like structures in the vestibule are not so well developed, and the fringe of hairs round the opening is uneven, being longest and thickest on the postero-ventral border. The ventral rim bears, in addition, a single large seta (Text-fig 47)



Text-figures 40-44 Imaginal respiratory system

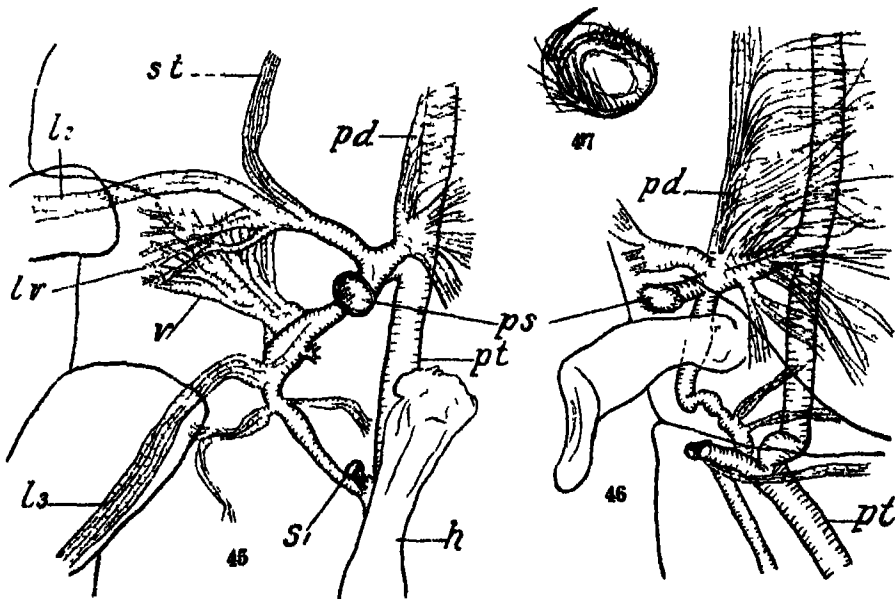
40 Tracheal system in thorax. Dorsal view, semi-diagrammatic (x 36) 41 Ventral view of anterior portion of the same (x 36) 42 Tracheae in region of anterior spiracle. Dorsal view, with primary trunk removed (pt) (x 57) 43 Anterior spiracle (x 133) 44 Abdominal spiracle viewed through the side of body (x 133) 44a Surface view of same (x 133)

as, anterior thoracic spiracle, li, tracheae to prothoracic leg, mc, meta-thoracic lateral commissure, n, tracheae to neck and head, ps, posterior thoracic spiracle, pt, primary trunk, sl, spiracle of first abdominal segment, st, secondary trunk, x, mid-ventral tracheae, y, tracheae to lateral region

The abdominal spiracles—A pair of spiracles is situated dorso-laterally, close to the anterior margin of each of the first seven abdominal segments. They lie in deep depressions in that part of the lateral integument which bears an ornamentation of short, dark hairs. The depression forms the atrium of the

spiracle, and the hairy covering is continued a short distance into its cavity. At its inner extremity there is a thick dark rim of chitin, which marks the point of attachment of the tracheal tube of the pupal spiracle, and which forms the valve of the imaginal spiracle. It has the shape shown in Text-fig 44, being continued dorsally into a pointed lever-like prolongation. It leads into a short vestibule, with thin transparent walls, which are not supported by the spiral thickening present in the trachea and are almost invisible. No inner valve is discernible at the junction of vestibule and trachea.

Tracheae—A notable feature of the tracheal system of the adult *Metoponia* is the absence of the great air-sacs which constitute such an important part of the system in the Muscidae and other actively flying Diptera. The tracheae are greatly enlarged in certain areas, but appear to consist throughout of unmodified, cylindrical vessels, which exhibit the typical spiral arrangement in their walls. The primary trunks (*pt*) are simple vessels of large calibre, which bend sharply in towards the median line from the anterior spiracles, and, a little behind the level of the spiracles, are connected by a short transverse commissure, which seems to represent the mesothoracic commissure of the larva and pronymph (Text-fig 40). Behind this, they diverge slightly and occupy much the same position



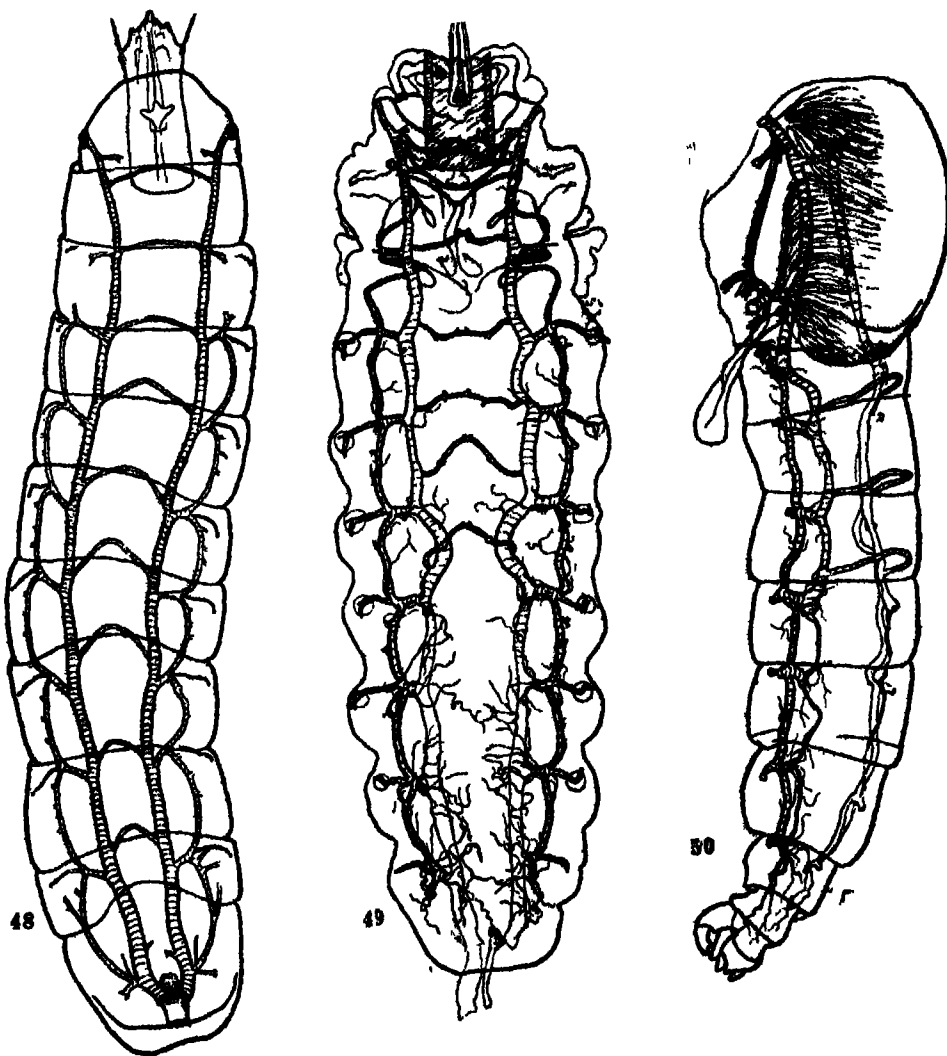
Text-figures 45-47 Imaginal respiratory system

45 Latero-ventral view of tracheal system in region of posterior thoracic spiracle (x 57). 46 Dorsal view of the same (x 57). 47 Posterior thoracic spiracle (x 183)

h, haltere, *l2*, *l3*, tracheae to meso- and metathoracic legs, *lv*, latero-ventral tracheae, *pd* postero-dorsal tracheae, *ps*, posterior spiracle *pt*, primary trunk *st*, first abdominal spiracle, *st*, secondary trunk, *v*, ventral tracheae

as in the earlier stages, extending down dorso-laterally through thorax and abdomen to the fourth abdominal segment (Text-fig 50). In the abdomen the

tracheal system is exactly as described for the protonymph. In the thorax the post-nymphal development of tracheae is characterised by a multiplication of fine tracheoles in faggot-like bundles, which, instead of single large vessels, take the place of the original single tracheae. As in the abdomen, the original ground



Text-figures 48-50 showing development of imaginal tracheal system from the larval system (x 23).

48 Larva 49 Pronymph 50 Imago (Only the body of imago is shown, without head or thoracic appendages)

plan of the system is still discernible its main features are shown in the accompanying figures (Text-figs 40, 46). A short and very wide trunk (m.c.) extends in from the metathoracic spiracle to the primary longitudinal trunk. The

segmental loop, forming part of the secondary longitudinal trunk, which connects this with the first abdominal spiracle (S1), is much enlarged, and dips down sharply towards the ventral surface, where it gives off the bundle of tracheoles to the third leg (L3). Just in front of this a massive bundle takes its origin from a swollen portion of the loop (v) and, after a short course, the individual tracheoles from it spread out fan-wise to supply the mid-ventral region of the thorax. The anterior segmental loop, which forms the most anterior portion of the secondary trunk, extends along the sides of the thorax in a deeply ventral position (st). It originates in a wide vessel given off antero-ventrally from the metathoracic spiracular commissure, which soon breaks up into three bundles of tracheoles, the foremost forming the segmental loop, the next the tracheal bundle to the mesothoracic leg (l2), and the third a radiating system of tracheoles supplying the latero-ventral region of the mesothorax (lv). Close to its junction with the primary trunk, just behind the anterior spiracle (as), two bundles are given off from the secondary trunk, the inner of which bends down towards the mid-ventral line, where its vessels come into contact, if they do not actually junction with those of its fellow from the opposite side (x). The outer bundle consists of very numerous tracheoles which spread out to supply the side walls of the thorax between the anterior spiracle and the wing (y). This secondary trunk system forms the first of the four large groups of bundles given off from the primary trunk at the same point just behind the anterior spiracle. The second is the bundle which supplies the prothoracic leg (l1). On its inner side, just before it enters the leg, it gives off a small cluster of tracheoles which meet with those from the opposite side (Text-fig. 41), and apparently represents the anterior ventral commissure which was noted in the pronymph. The third group consists of a thick bundle which passes inward to the neck (n), and, with its fellow from the opposite side, forms the tracheal supply to the head. Several tracheoles pass straight across between these bundles below the neck, and form an anterior commissure which seems to represent the prothoracic dorsal commissure of the pronymph. The course of the tracheae in the head could not be followed out. The antero-dorsal area of the thorax is supplied by dense clusters of radiating tracheoles which arise dorsally from the same spiracular region of the main trunk. These are shown only on Text-fig. 50. The postero-dorsal region, including the scutum and scutellum, and most of the dorsal muscles, is supplied by similar clusters of tracheoles arising from the dorsal side of the large trachea connecting the metathoracic spiracle with the primary trunk. The bundles which are given off anteriorly extend straight forward, separate tracheoles from them passing out at right angles and forming a parallel series to the muscles all the way up the thorax (Text-fig. 46, p d).

Summary.

The following are the most important of the features of the respiratory system described in this paper:—

1. The larva is peripneustic, both functionally and structurally, having spiracles on prothorax, metathorax, and on the first seven abdominal segments, and posterior spiracles opening internally in a preapical air chamber. The anterior spiracles are large, the other lateral spiracles very minute. An additional pair of spiracles appears to be present on the head.
2. The spiracles of the newly-hatched larva are exactly similar in number and

- in form to those of the fully mature larva, but in the older larvae a papilla-like fold is developed behind each abdominal spiracle
- 3 These folds mark the position of the pupal spiracles, which begin to develop, in discs surrounding the larval spiracles, a considerable time before pupation
 - 4 At pupation the neck of each pupal spiracle, from the 1st to the 6th abdominal, penetrates to the exterior of the larval skin through the papilla. It communicates internally with the tracheal system of the pupa through a complicated stigmatic chamber and a tracheal vessel which lie in the space between the body of the pupa and the puparium, and is functional throughout the whole pupal period
 - 5 The pupal stigmatic apparatus is detached, when the imago escapes, by the severance of the connecting trachea below the surface of the body, the ruptured end of the trachea forming the vestibule of the imaginal spiracle
 - 6 The imaginal spiracles occur on prothorax, metathorax, and on abdominal segments 1-7, the prothoracic spiracles are developed in immediate relation with those of the pupa and larva, but the metathoracic spiracles are not distinguishable in the pupa until the last stage before the emergence of the fly
 - 7 The tracheae of the larva do not disintegrate, but continue to function during the pupal metamorphosis, the tracheal system of the imago being formed by direct development from the larval system the general plan of this can be traced through all intermediate stages, and is still clearly recognisable in the adult fly
 - 8 In the larva a series of closed segmental loops is formed along each side of the body by the longitudinal junction of external branches from the main tracheal trunks. These loops become strongly developed in the pupa, and eventually form a secondary longitudinal trunk on each side parallel with the primary trunk, and connected with it and the spiracles by transverse commissures
 - 9 The greatly increased growth of tracheal branches which occurs in the later stages of pupation is connected almost entirely with these secondary trunks and their commissures, and the primary trunks do not persist behind the fourth abdominal segment
 - 10 There are three distinct stages in pupal metamorphosis, viz. pronymph, nymph, and promago, marked by at least two, possibly three, ecdyses, during which portions of the tracheal endings are shed, and distinct developmental changes occur in the respiratory system
 - 11 The tracheal system of the imago is already well developed in the promago, and is very conspicuous for some time before the emergence of the adult fly
 - 12 The tracheae of the imago retain the form of cylindrical vessels with a spiral arrangement of the intima. Thin-walled membranous air-sacs are not discernible. In the thorax the imaginal development of the tracheal system is characterised by the formation of thick faggot-like bundles of fine tracheoles

Note on the comparative morphology of the spiracular apparatus

Dr Meijere made a special study of the stigmata of larva and pupa in a large number of families of Diptera, and published the results in two papers (1895, 1902) which form the most important contribution to our knowledge of this subject

As a result of the special investigation, in the present paper, of the Stratiomyid stigmata, we are now in a position to consider these structures in the light of de Meijere's general account and discuss the conclusions which he reached. He has shown that the anterior and posterior stigmata in all the Diptera larvae examined by him conform to the same general plan, i.e., that they all possess a more or less well developed stigmatic chamber, called by him the "Filzkammer," which communicates with the surface by a variable number of oval or rounded spots (Tupfelstigma), borne generally on short branches of the "Filzkammer" with enlarged ends (Knospen), and a remnant of an older tracheal ending, which he terms "Narbenstrang," attached to the integument and to the base of the "Filzkammer" by an outer and inner stigma scar (Stigmennarbe). These features are all recognisable in both the anterior and posterior spiracles of the Stratiomyid larva and the abdominal spiracles of the pupa.

De Meijere's investigations were concerned mainly with the Nematocera and the Cyclorhapha, and the structure of the abdominal spiracles of the Stratiomyid pupa has evidently not been observed by him or any other worker. But he has shown that, in the peripneustic pupae of the Nematocera, the abdominal and prothoracic spiracles are alike and resemble those of the prothorax of the larva, whereas, in the more advanced Cyclorhapha pupae, the abdominal spiracles have ceased to function, and the prothoracic spiracles have become modified at the tip into horny cornua (Athemhorner), which break through the wall of the puparium to function in breathing. It is now evident that, in their mode of formation and general structure, the abdominal spiracles of the Stratiomyndae show a close relationship with those of the Nematocera. They have a broad general resemblance to the abdominal spiracles of the Mycetophilid pupa, *Mycetophila cinerea* Meig., which de Meijere figures as typical of the Nematocera. But the long, narrow, horny neck which perforates the puparium wall is distinctive, and recalls the prothoracic stigmata of the Cyclorhapha. Other peculiar features of the abdominal spiracular apparatus of *Metoponia* are the great distance at which it is situated outside the body of the pupa, the remarkable length of the tracheal trunk attaching it to the body, and the bulbous shape, large size, and complex development of the stigmatic chamber (Filzkammer).

De Meijere rightly remarks that, in the Stratiomyndae, the prothoracic stigmata of the pupa are not specially developed, being represented only by weak-skinned colourless projections. And he records the pupae as peripneustic, but considers that the lateral stigmata are not connected with the body of the pupa by functional tracheae. Commenting on Baurer's statement that in the Stratiomyndae and Cyclorhapha the puparium case remains in vital connection with the pupa, he says "Diese Durchtrittsstellen sind aber die Stigmennarben, welche bald fast ganz verschlossen sind, auch sind die alten Tracheen so bald zusammengeschrunpft, dass ihnen für die Athmung der Puppe wohl, wenigstens in den spätern Stadien, keine Bedeutung beigemessen werden kann." But close investigation has now shown that these abdominal spiracles form the only functional breathing apparatus of the pupa, and that they function in the same way as the prothoracic stigmatic cornua of the Cyclorhapha.

With reference to the old tracheal ending round which the Filzkammer is formed, whether in the larva or pupa, de Meijere considers that it always falls together to form a solid cord, whence the name "Narbenstrang." But it is

doubtful if this is so in the *Stratiomyidae*. It has been shown that the cuticular intima of these tubes is shed in an ecdysis which occurs after the stigmatic chamber is fully formed, so that they must possess a lumen up to this time. And even after it they have not the appearance of solid cords, nor do their ends appear to be overgrown to form closed stigma scars.

Special interest attaches to the perforation of the wall of the puparium by the horny neck of the abdominal spiracles.

De Meijere devotes much attention to this "Durchbruch" in the case of the *Cyclorrhapha*, but makes the definite statement that it does not occur outside this group. "Es kommt dies nur bei Cyclorrhaphen vor, indem bei den Stratiomyiden (der einzigen Familie der Orthorrhaphen, wo es ebenfalls zur Bildung eines Pupariums kommt) die Prothorakalstigmen auf nur sehr wenig hervorstehenden, conischen Warzen aufsitzen." His mistake is due to the fact that he had overlooked the abdominal spiracles of the *Stratiomyidae*, and was considering only the feebly developed prominences which, in this family, represent the stigmatic horns of the prothorax. In the *Cyclorrhapha* the perforation of the puparium wall is shown by de Meijere to occur on different segments of the pupa in different genera, e.g., on the 1st abdominal segment in many *Syrphidae*, and on the 2nd abdominal segment in the *Phoridae*, but in all cases only a single pair of horns is developed, which belong to the prothoracic spiracles.

It is evident from the observations of de Meijere himself and other authors whom he quotes, that the spots at which the perforations will afterwards occur are already distinctly observable on the larval skin in some, if not all, *Cyclorrhapha*, just as they are in *Metoponia*. As long ago as 1740 Reaumur had noticed these spots on *Ernstalis tenax* L., and described them as light circles on a dark ground, closed only with a thin hyaline membrane. And he recognised and described the pupal horns in process of formation below them, and stated that the time which elapses, after the formation of the puparium, before the horns perforate the spots, varies from 24 hours to 3 or 4 days, according to the time of the year. Perris (1870) witnessed, in *Xylota nigra* F., the actual process of perforation, and found that it only occupied a few seconds.

Thus, then, is clearly analogous to what occurs on the abdominal segments of *Metoponia*, and the study of the latter has revealed, in a very striking way, the intermediate position which the *Stratiomyidae* occupy between the *Nematocera* and the *Cyclorrhapha*. The complete development of compound lateral stigmata links them, on the one hand, with the most primitive of the *Nematocera*, and the modification of these structures, to provide for an air supply to a "mummified" pupa enclosed in a puparium, indicates the beginning of a process which is carried to its highest development in the *Cyclorrhapha*.

De Meijere discusses the problem of how the special places on the larval skin could have arisen in the *Cyclorrhapha*, and become adapted to the part they play in the thrusting forth of the stigmatic horns. He offers the tentative suggestion that the horns first succeeded in breaking through in species which possessed a relatively thin wall to the puparium, and that, as the wall gradually hardened, the development of the imago was successful only in those which still preserved thin spots. In the *Stratiomyidae* we have found the family in which, apparently, the adaptation originated, and it is here that its development can be studied most profitably.

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Postscript, added April 18th, 1923—From larvae collected on November 4th, 1922, showing fourth stage papillae, a male *Metoponia rubriceps* emerged on April 4th, and a female on April 9th, 1923, and the three remaining larvae have now pupated. The male lived for eight days and the female for five

STUDIES IN SYMBIOSIS

III CONTRIBUTION TO THE MORPHOLOGY AND PHYSIOLOGY OF THE
ROOT-NODULES OF *PODOCARPUS SPINULOSA* AND *P. ELATA*.

By John McLuckie, M A, D Sc, Lecturer in Plant Physiology, University of
Sydney.

(With twenty-one Text figures)

[Read 28th March, 1923]

Introduction.

Recent research has extended our knowledge of organisms capable of utilising the free atmospheric nitrogen. It is now known that plants having affinities with groups other than the Leguminosae have this faculty. Fixation of free nitrogen has been definitely proved to occur in the Cycadaceae, in the Podocarpaceae, in *Alnus*, *Eleagnus*, and *Myrica gale*. All these plants possess some form of root-nodules or tubercles which are inhabited by an organism capable of nitrogen fixation. Bottomley (1907) isolated from the nodules of *Alnus* and *Eleagnus* a bacillus which, in pure culture, he employed to inoculate the roots of *Vicia sativa* seedlings. The result of these cross-inoculation experiments was the formation of root-nodules characteristic of those formed in nature by the organism *Pseudomonas radicicola* upon the roots of Leguminous plants.

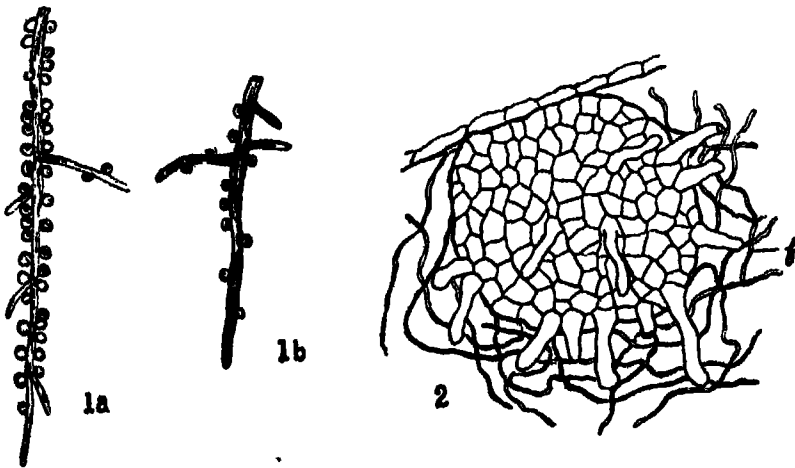
In 1899, Nobbe and Hiltner proved that the nodules which occur upon *Podocarpus* roots have the power of nitrogen fixation. They demonstrated, by their experiments, (1) that it is impossible to cultivate *Podocarpus* in the absence of the organism which causes nodule formation; and (2) that *Podocarpus* may be cultivated in pure quartz sand, containing no combined nitrogen, to which only the atmospheric nitrogen had access.

In the earlier investigations on *Alnus*, *Eleagnus*, and *Podocarpus*, hyphae-like structures were observed in the cells of the nodules, and it was claimed that these represent a mycorrhizic fungus to which the power of nitrogen fixation could be attributed. The hyphae-like structures were frequently disorganised and digested by the root cells (Shibata, 1902). These conceptions, however, have not stood the test of the most recent research, and the investigations of Bottomley and Spratt leave no doubt about the bacterial origin of the root-nodules in these organisms. Spratt (1912) has demonstrated that *Pseudomonas radicicola* stimulates the nodule formation in *Alnus* and *Eleagnus*, and that bacterial infection is responsible for the development of the nodules in *Podocarpus totara*, *P. chilensis*, *P. alpinus*, *Microcachrys tetragona*, *Dacrydium Franklini*, *Saxegothaea conspicua* and *Phyllocladus trichomanoides*.

In the present note the author records results of a detailed study of the nodules of two other species of *Podocarpus*, namely, *P. spinulosa* and *P. elata*, which occur in the New South Wales Flora

The Nodules of Podocarpus spinulosa

In *Podocarpus spinulosa* the nodules are small, practically spherical, numerous and arranged in two close rows along the sides of the root. In *P. elata*, the nodules are also spherical, but less numerous than in the former species (Text-figs. 1a, 1b). Branching of the root-system is relatively infrequent. The nodules arise mainly upon the root-hair zone of the mother root, and each nodule possesses numerous, normal-looking root-hairs. In the young nodules these hairs are apparently functional as they contain protoplasm and a nucleus. On the older nodules the hairs have collapsed and become partly torn away, but their vestiges



Text-figs 1a, 1b—Portion of roots of *Podocarpus spinulosa* and *P. elata* showing the root-nodules (x 2/3)

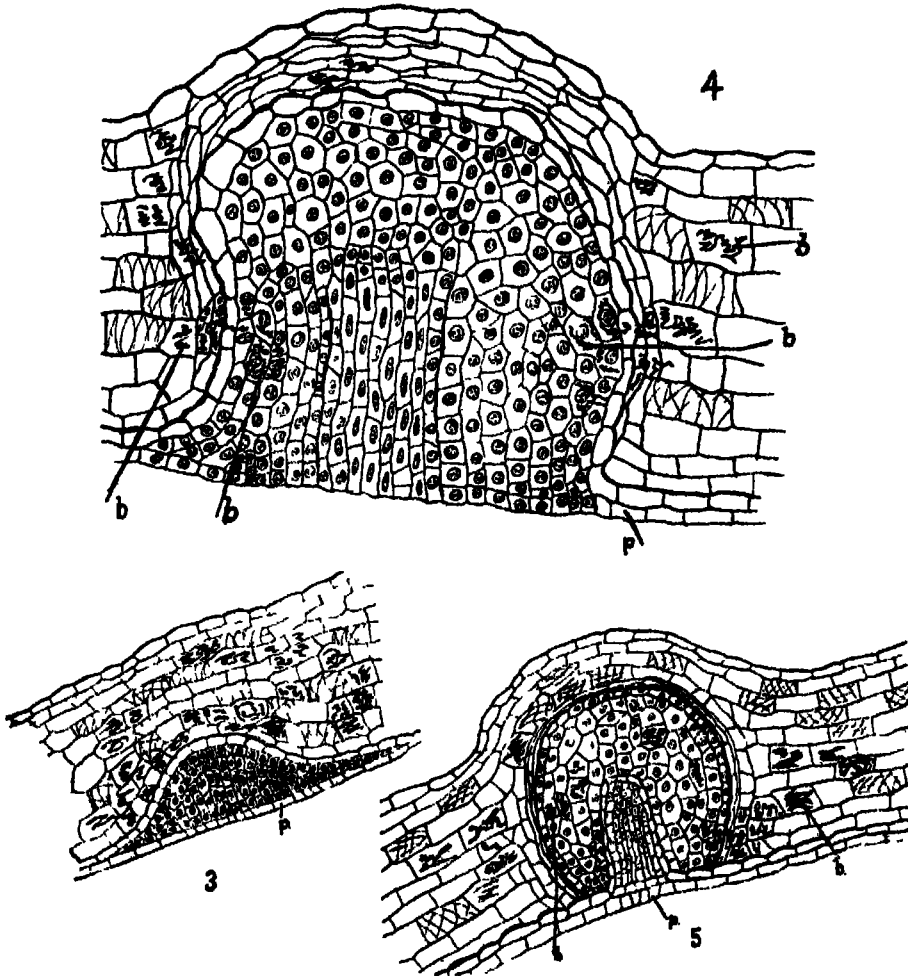
Text-fig 2—Surface view of a root-nodule of *P. spinulosa* showing the root-hairs and the hyphae of a fungus (f) (x 33)

are apparent. In the species I have examined, the hairs upon the nodules are not so numerous as described in other species. In a nodule which has just reached maturity the hairs do not develop simultaneously, and hairs of various stages may generally be seen. They arise from ordinary epidermal cells of the nodule and are similar in all respects to normal root-hairs. Around each nodule and along practically the entire surface of the main root, there is a comparatively dense tangle of fine, fungal hyphae, some of which undoubtedly enter the root and, frequently, the nodule.

Each nodule is endogenous in origin, and represents a modified lateral root, arising from the pericycle. A small vascular strand enters the nodule, and is connected with the vascular tissue of the main root, while the surrounding cortical cells of the nodule are enlarged and thin-walled. Many of these cortical cells are filled with wide hyphae-like threads traversing the cell cavities in different directions. These have been interpreted by early observers as the hyphae of a mycorrhizic fungus. Sections stained in (a) Gentian violet, Lugol's iodine and safranin, and in (b) Amyl gram stain (Kiskalt's) demonstrate that these threads are

zoogloal in nature and are occupied and formed by rod-shaped bacteria which occur in large numbers. The threads are of variable width, and the bacteria pass from cell to cell within them. The threads widen considerably before entering a new cell (Text-fig 8a), much in the same way as Spratt has observed in other species of the Podocarpaceae. In some cells, however, numerous small free colonies of bacteria occur outside the threads, and these divide independently of the organisms in the threads (Text-figs 7, 8).

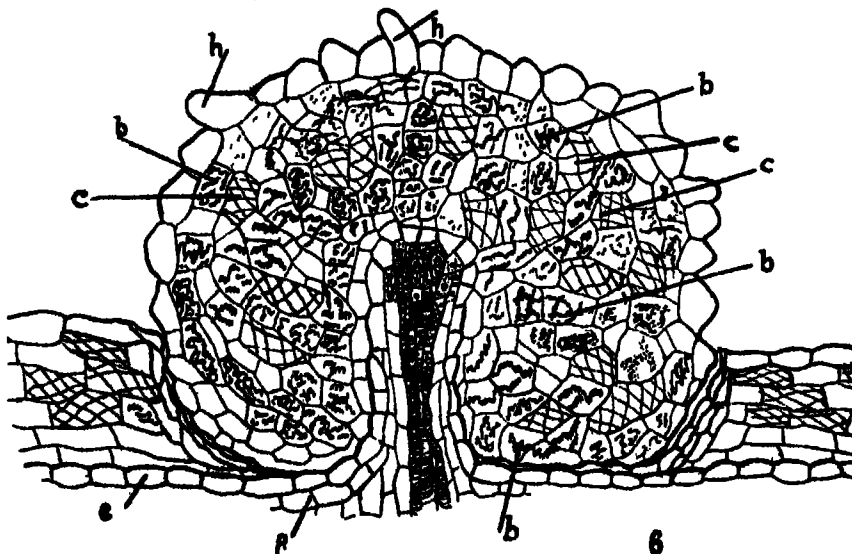
In a few instances I have observed entire cells filled with these colonies of free individuals.



Text-figs 3, 4, 5—Longitudinal section of main root, through young root-organs. The nodules arise from the pericycle (p), and their early development is similar to that of normal lateral roots. In figures 4 and 5 the meristematic cells of the pericycle are infected by bacteria (b) which enter from the cortex of the main root (Figs 3 and 5, x 30, Fig 4 x 120).

The bacteria mass together round the nucleus when free, or the zoogloea threads coil round the nucleus; the latter again may undergo amitotic division in the presence of the bacteria. I have seen as many as four nuclei in an infected cell, but have not observed any stages in a normal mitosis. The shape of the nucleus also is very irregular as is shown in Text-fig 21. In Text-fig 21a, one of the nuclei is centrally constricted and apparently about to fragment. This irregularity in the form of the nucleus has been observed by Spratt (1912) in the nodules of *Eleagnus* and various members of the Podocarpaceae, and by the author (1922) in the cells of *Dipodium punctatum* infected by an endophytic fungus. The cytoplasm and nuclei of many of the nodule cells disintegrate and many of the bacteria leave the cells in which disintegration is taking place. These cells become strengthened by bars of thickening, which gives them a tracheidal-like appearance. Many of them are absolutely empty, but some contain the remains of zoogloea-threads, and numerous quiescent bacteria. The resting bacteria appear larger than the active individuals.

Towards the end of the seasonal vegetative activity of the plant, the root-nodules become more or less completely transformed into masses of tracheidal-like cells, probably functioning later in water storage. These cells also appear in the cortex of the older portion of the main root.

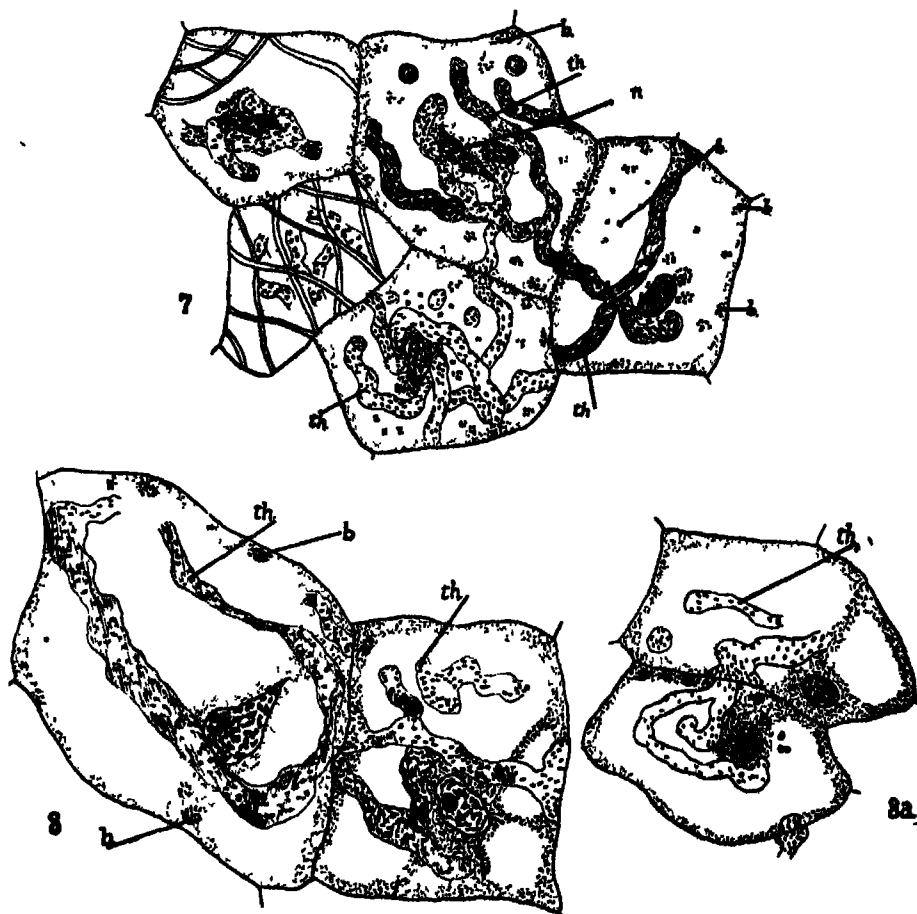


Text-fig 6—Longitudinal section of main root through mature nodule which is highly infected with the bacteria (b). Some of the cortical cells (c) have already been strengthened by the bars, while young root hairs are developing (h). (x 120)

In the spring new cortical tissue is formed within the old from the meristematic tissue within the endodermis. The outer, dead, cortical cells of the nodule consequently become crushed and disorganised.

In *Podocarpus spinulosa*, the bacteria enter the root by means of the young root-hairs, and I have frequently seen young zoogloea-threads of the bacteria within the hairs passing inwards towards the cortex of the root. The bacteria multiply rapidly and numerous threads spread out in various directions into the

adjacent cells of the cortex. These zoogloea-threads in many cases look like fungal hyphae, but the bacteria can clearly be seen within them. In a very short time a considerable area of the cortex becomes infected. Threads of the bacteria spread into the young root origins and multiply within the meristematic cells. Text-figures 3, 4, 5, show the origin of the nodule from the pericycle (p), and the early period at which it may become infected by the bacteria (b). Infection

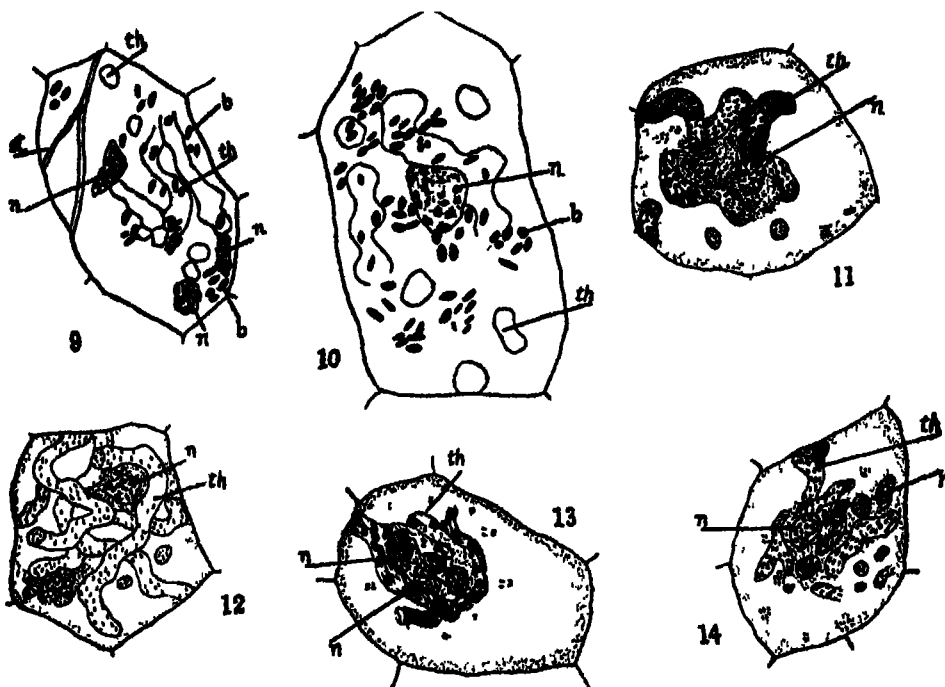


Text-figs 7, 8, 8a—Cortical cells of the mature nodule showing zoogloea threads of the bacteria (th) more or less coiled in the vicinity of the nucleus or nuclei, (b) free bacteria, (n) nucleus undergoing amitotic division ($\times 450$)

apparently arrests meristematic activity, but stimulates the rapid enlargement of the cells. Infected cortical cells become larger than uninfected. The nodule gradually develops through the overlying cortical cells of the mother root, and appears as a more or less globular swelling on the surface. Text-figure 6 shows a mature nodule just after it has ruptured the overlying tissues of the main root and emerged from them. The bacteria enter embryonic cells of young root origins in *Podocarpus*, and their presence leads to the cessation of cell division,

but stimulates a rapid enlargement of the young cells and, before the young root emerges from the cortex of the main root, many of its cortical cells are filled with bacteria which multiply rapidly, probably at the expense of the soluble carbohydrates which are associated with every active embryonic tissue.

The active bacteria in some of the cells stain less deeply with gentian violet than the larger individuals in other cells which have lost their protoplasm and become transformed into reticulately thickened tracheidal-like cells. In fact, the two kinds of individuals, the active and inactive, are readily distinguished by means of this difference in reaction to stain. These larger organisms are probably bacteroids. They are practically confined to the older cells of the nodules, in which disorganisation is taking place. The younger cortical cells of the nodule with dense granular cytoplasm contain the very characteristic zoogloea-threads.



Text-fig 9—Cortical cells from mature nodule with three nuclei (n) showing signs of disintegration, disorganising zoogloea threads (th) and resting bacteria (b) and the first thickening strands upon the cell wall (st) (x 720)

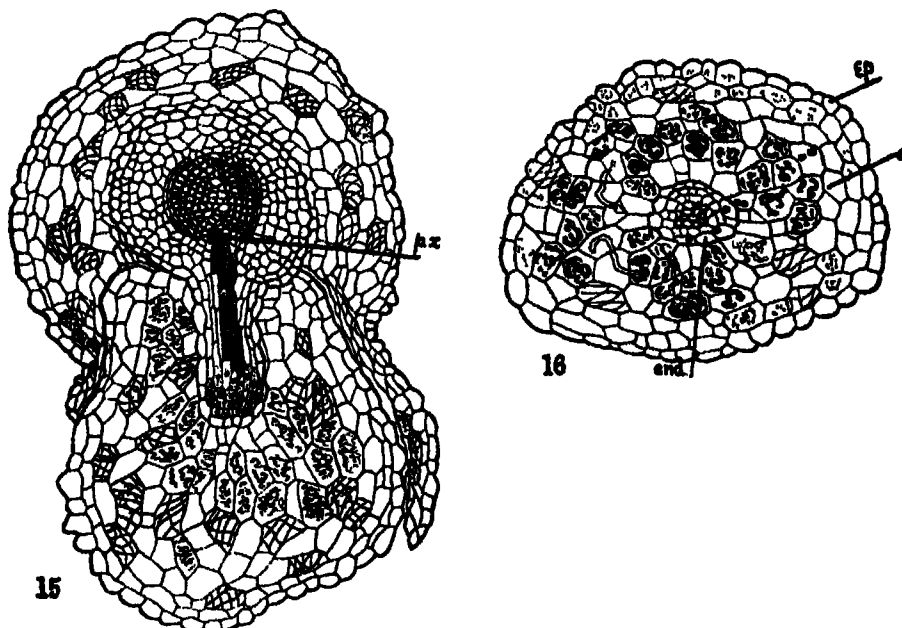
Text-fig 10—Small cortical cell containing the resting bacteria (bact:roids) and the disorganising threads and nucleus (x 900)

Text-figs 11, 12—Cortical cells showing zoogloea threads of bacteria and two nuclei surrounded by dense granular cytoplasm. (x 600)

Text-figs. 13, 14—Old cortical cells containing disorganising zoogloea threads and four nuclei from which the typical structure is disappearing (x 600)

of active bacteria, and there is no doubt that these active bacteria migrate from cell to cell in these threads, which very strongly suggest the "infection threads" of the tubercles of the Leguminosae (Text-figs 7, 8)

The threads almost invariably twine around the nucleus which, in the early infection stage, is in the reticulum condition. The cytoplasm of the cell is densely aggregated in the vicinity of the nucleus, which is the active chemical centre of the cell. I have not seen starch in these young infected cells, but since they occur in a zone just outside the endodermis of the nodule, and abundant starch is present in the cells of the main root at the base of the nodule, it is highly probable that the carbohydrate reaches the cells containing bacteria in the form of sugar. So long as the bacteria are active, i.e., during the vegetative activity of the host, they will consume carbohydrate which provides them with the necessary energy for nitrogen fixation, and there will be established the conditions required for a regular flow of carbohydrate from the tissues of the main root.



Text-fig 15—T S of main root through a root-nodule showing the origin of the latter opposite a protoxylem group (px) of main root ($\times 66$)

Text-fig 16—T S nodule showing epidermis (ep), cortex (c), endodermis (end) and stele ($\times 80$)

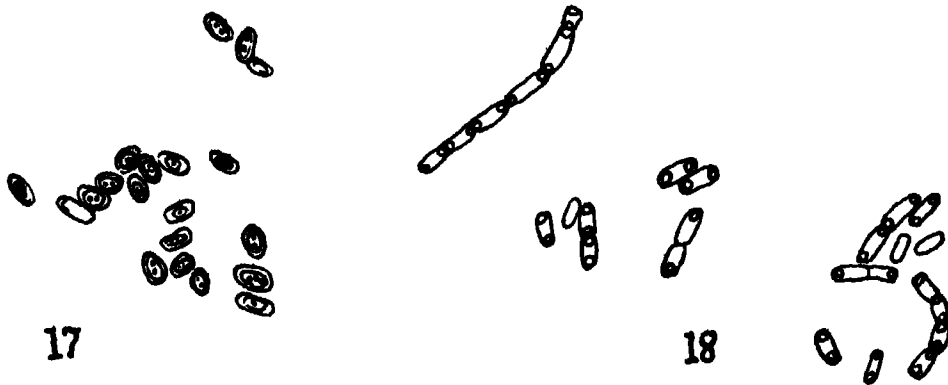
Towards the end of the active vegetative period, the bacteria pass into a resting phase during which they appear larger, and stain more deeply (Text-figs 9, 10). The cortical cells of the nodules become transformed into water storage tissue by the disorganisation of the cytoplasm and nuclei and the deposition of thickening strands upon the wall.

The single nucleus, in young infected cells, generally divides, and cells with 2, 3, and 4 nuclei are common (Text-figs 11—14). The chromatin contents become aggregated into small, irregular sized knots which rapidly disorganise. The root-gloea threads, at the same time, appear to disintegrate, and only small fragments of them may be evident. Many of these tracheidal-like cortical cells have

no resting bacteria in them, for the active bacteria, as a rule, migrate into the living epidermal and sub-epidermal cells of the nodule where they rest until the following season

Origin of the Root-Nodule

There is absolutely no doubt that the nodules are lateral roots, whose normal development has been arrested by bacterial infection. Text-figure 15 shows the origin of the nodule opposite one of the protoxylem groups of the diarch mother root. The connection of the central strand of tracheids of the nodule with the protoxylem group is clearly shown. Text-figures 3, 4, 5, show a longitudinal section of the main root through young root origins, and it is apparent that the pericycle cells become meristematic and divide to form a small swelling beneath the endodermis. At first the swelling is composed of a mass of small meristematic cells, with a large nucleus and granular cytoplasm, but, as the swelling develops, there are soon differentiated three distinct zones, namely, the plerome,



Text-fig 17—A group of the "coccus form" of the nodule bacteria showing thick wall and granular bodies (x 2000)

Text-fig 18—A group of the "bacillus form" of the nodule bacteria showing peculiar structures at each end (x 2000)

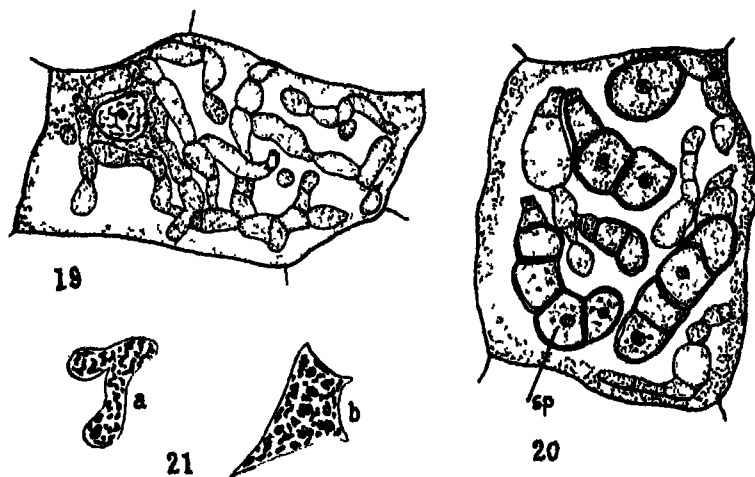
periblem, and dermatogen. As the young root develops, a distinct protuberance appears on the surface of the main root, while the overlying cortical tissue of the latter becomes crushed by the growth of the young root through it. A few of these lateral roots develop normally, but the great majority become infected by bacteria before they emerge from the cortex, and their normal growth is retarded, so that they develop as the more or less spherical root-nodules. Each mature nodule possesses a diarch stele, as shown in Text-fig 16, clearly delimited from the cortex by an endodermis, the outer cell-walls of which are strongly thickened. Most of the endodermal cells contain a tannin deposit.

The bacteria, which are clearly seen to be present when the living nodules are crushed out upon a slide, were isolated and pure cultures of them made. The surface of the nodules was sterilised in a solution composed of 25 cc of concentrated hydrochloric acid, 1 gram of mercuric chloride, and 500 cc of distilled water, for two minutes, and subsequently washed several times in distilled water. The nodules were then crushed with sterile instruments upon a nutrient

agar medium in test tubes, so that the contents of the cortical cells were pressed upon the surface of the nutrient medium; the tubes were securely plugged in the usual manner, and incubated for several days at a temperature of 25.5°C. After 48 hours, vigorous colonies of the bacteria were developed upon the nutrient substratum. These colonies increased in diameter from day to day, their surface was raised, translucent, shining and very mucilaginous.

Some of the bacteria were isolated upon a slide and stained in (1) gentian violet, Lugol's iodine, and safranin, and (2) carbol fuchsin. The bacteria are short rod-forms, which may occur in long chains or free. They stain deeply with the gentian violet, the stain is, however, almost entirely extracted with ethyl-alcohol (95%) and is untouched with amyl-alcohol. This reaction would suggest *Pseudomonas radicola* according to the investigations of Harrison and Barlow (1906).

The pure cultures upon nutrient agar, direct from the nodules, contained two kinds of individuals, namely an elliptical coccus-like form (Text-fig. 17), and a typical rod-shaped form. The former had a comparatively thick wall and contains one or two small granular, deeply staining bodies, it frequently occurred in short bead-like chains. The latter was thin-walled and at each end had a small circular dense area. This bacillus form frequently occurred in long chains although isolated individuals are not uncommon in cultures (Text-fig. 18).



Text-fig 19—A cortical cell of *P. spinulosa* root showing an endophytic septate fungus (x 610)

Text-fig 20—A cortical cell showing the hyphae bearing chains of thick-walled spores (x 610)

Text-fig 21—Peculiar forms of nuclei in cortical cells of nodule some time after infection (x 900)

There is no doubt in my mind that these two forms are phases of the same organism. Firstly, each form has been demonstrated within the cortical cells of the nodule, the bacillus form preponderating in the young infected cells of the nodule, the coccus form in the older cortical cells. Secondly, when cultures were made from the outer, and older cortical cells only, in most cases only the coccus phase was present, while cultures made from the central and inner cortical cells contained mainly the bacillus forms. Cultures made from the whole crushed

nodule at first contained the coccus form in abundance and later the bacillus forms. The organism in the nodule of *Podocarpus spinulosa* and *P. elata* is polymorphic. I cannot definitely identify it as *Pseudomonas radicina*.

The bacteria were next studied from the point of view of nitrogen fixation. For this purpose the following nutrient solution was prepared—Cane Sugar 5 grams, acid potassium phosphate 1 gram, Magnesium sulphate 5 gram, Calcium carbonate 5 gram, Distilled water 1000 c.c. Solution neutralised with Sodium-hydrate.

One hundred cubic centimetres of this solution were placed in four flasks of 300 c.c. capacity, A, B, C, D, the flasks A, B, and C were sterilised in an autoclave for 30 minutes at a temperature of 140°C. and a pressure of 2½ atmospheres, neutralised with NaOH and cooled. Each flask was then inoculated by transferring bacteria from the test-tube cultures by means of a platinum loop. The flask D was used as a control. It was inoculated in the same manner as the flasks A, B and C, neutralised, then placed in the autoclave at 140°C. at 2½ atmospheres pressure for 30 minutes and cooled. The four flasks were then placed in an incubator at a temperature of 25.5°C. In the course of a few days the solution in A, B and C became quite cloudy, whilst that in D remained clear. The flasks were incubated for 21 days at 25.5°C. and their contents were then examined for nitrogen by the Kjeldahl method of analysis. The following results were obtained—

	Nitrogen in culture solution
A.	6.53 mg
B.	7.02 "
C.	6.79 "
D.	trace only

In the flasks A, B and C, a vigorous fixation of nitrogen took place, while in D a mere trace was found. The obvious inference is that the increased nitrogen content of A, B and C was due to the living bacteria introduced, fixing the free atmospheric nitrogen. In the flask D, owing to the difference in the treatment, the bacteria were killed. No other conclusion can be drawn from the results of these experiments, than that the bacteria of the nodules of *Podocarpus spinulosa* are capable of fixing free nitrogen.

In some of the nodules which I examined, true fungal hyphae were present in some of the outer cells (Text-fig. 19). These hyphae were identical in structure with others which I observed in the cortex of the main root and forming a close tangle around a considerable portion of the surface of the younger part of the root. These hyphae are generally confined to the superficial cells of the nodule and mother-root, but they sometimes occur in the deeper cells of the cortex. They produce peculiar thick-walled, spore-like bodies in some of the cortical cells (Text-fig. 20, *sp.*). The spores arise in short chains and are formed from the hyphae by their division and subsequent swelling. Each cell of the spore chain has a thick, brownish wall, and contains one nucleus, and oil drops. These hyphae are probably mycorrhizal in function, living symbiotically with the host root, and their relation to the root is rather of the ectotrophic nature than endotrophic.

Summary.

1. The root-nodules of *Podocarpus spinulosa* and *Podocarpus elata*, like those of other species and genera of the Podocarpaceae, are actively engaged in nitrogen fixation by virtue of the bacteria present in the cortical cells.

- 2 The nodules are modified lateral roots and arise from the pericycle, their normal growth is arrested by bacterial infection before they emerge from the cortex of the main root
- 3 The meristematic activity of the cells of the nodule origins is inhibited and their subsequent increase in size is due to the enlargement of the cells of the pericycle
- 4 Root hairs are commonly present upon the nodules
- 5 Bacteria enter the cortical cells of the nodule from the neighbouring cortical cells of the main root and multiply rapidly, spreading from cell to cell by means of gelatinous "zoogloea-threads" of variable width
- 6 The zoogloae coil in the vicinity of the nucleus, and are seldom branched. The active bacteria are in the form of small rods, but the inactive "bacteroids" are larger and oval in shape. The latter are abundant in the outer cells of the cortex, and in the epidermis of the nodule
- 7 In infected cells the cytoplasm becomes disorganised towards the end of the functional period of the nodule, the nucleus fragments, and the chromatin becomes coarsely granular. As many as four nuclei occur in some cells. The walls of the older cortical cells become strengthened by loosely arranged bars of thickening, giving them a tracheidal-like appearance. The zoogloae in such cells gradually disintegrate with the cytoplasm and nuclei
- 8 All the outer cells of the cortex of the nodule become modified by thickening of their walls, and the loss of their contents. The same nodule generally shows all conditions between cells with active bacteria, and the empty-looking water-cells
- 9 The nodule may form within that of the previous season, and the outer cortical tissues therefore become crushed and distorted
- 10 The bacteria were isolated from the nodules and incubated on sterilised solid and liquid media. They undoubtedly possess the capacity for the fixation of nitrogen
- 11 The nodules and the cortex of the main root frequently contain fungal hyphae and peculiar spore-like bodies belonging to the fungus
- 12 The surface of the nodule and main root is frequently invested with a loose tangle of fungal hyphae, some of which enter the root tissues
- 13 The bacteria of the nodules render the free nitrogen of the atmosphere available to the plant, and therefore make the latter independent of other forms of nitrogen

I desire to record my sincere thanks to Professor Lawson for his helpful suggestions

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A REVISION OF THE AUSTRALIAN DIPTERA BELONGING TO THE GENUS *SARCOPHAGA*

By Professor T HARVEY JOHNSTON, M A , D Sc , The University, Adelaide, and
G H HARDY, Walter and Eliza Hall Fellow in Economic Biology, The
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(Twenty-eight Text-figures.)

[Read 30th May, 1923]

Australian species of Sarcophagid flies were first described in 1830 by Robineau Desvoidy, others were added by Macquart in 1846 and 1850, Walker in 1849, and Thomson in 1868. In more recent times, Skuse described a species in 1891, and Taylor another in 1917.

During 1921-22, papers on Sarcophagid flies were published by Johnston and Tiegs, the specific differentiation being based upon genitalic characters and an attempt was made to attach to the more common species most of the thirteen names given by earlier authors. Parker, in 1922, described two species as new but, as indicated below, both these had already been described by Johnston and Tiegs.

In preparing this revision it was our intention to establish a system whereby identifications could be made from female specimens and our study of the chaetotaxy was undertaken mainly for this purpose, but it was soon found that a critical study of the genital parts had to be undertaken first so as to eliminate errors due to imperfections of previously studied material and to the misunderstanding of the limits of variation in the male. We are convinced that the chaetotaxy of the female conforms to that of the male in regard to certain features which may be used in specific determination, and in several cases, where this rule has not been applicable, it is possible that an error has been made by attaching wrong identification labels to material previously studied.

This revision completes the first step towards establishing a satisfactory taxonomic treatment of Australian Sarcophagid flies in so far as it revises the treatment of male genital parts, giving descriptions as well as drawings of outstanding features and adding a comparative study of the chaetotaxy, that portion relating to the abdomen and femora not having been attempted before.

The new names added to the Australian list include those of one new species, one previously wrongly identified, for which a new name is proposed below, and also for one that previously was only recorded from Europe and North America, namely *S. securifera* Villen. Eight names are placed as synonyms for the first time.

The term "Australian," as used in this paper, does not include localities such as Lord Howe Island, New Guinea and islands in its vicinity

The first key for the determination of males is based entirely upon genital characters. The second key is based mainly on a selection from the chaetotaxy and other characters that we consider sufficiently constant to warrant their use in this way. The third key for the determination of the females is the first published attempt to isolate females, mainly on the chaetotaxy, and can include, of course, only species of which the females are known. Until more material is bred and the females determined in this manner, it is uncertain whether our key will ultimately be found reliable, though we believe it will prove to be so in most cases.

Acknowledgments—We are indebted to Dr C Anderson and Mr H A Longman, the Directors of the Australian and Queensland Museums respectively, and to Mr G F Hill, Entomologist of the Institute of Tropical Medicine, Townsville, for the loan of those types of Sarcophagid flies that are respectively under their charge, to Dr E W Ferguson, Mr G H Dutton and others for the loan of specimens in their collections.

From Mr R R Parker we received a letter in which he informed us that his two species, described as new, were forestalled by Johnston and Tiegs, and suggested certain further synonymy to which we have given due consideration.

Chaetotaxy

(A) The bristles of the head (Text-fig 1) are classified as follows—

Vertical. Two pairs, inner and outer, situated in a line behind the ocelli, the inner pair always long and convergent, the outer pair always divergent, shorter and situated near the corner of the eyes and, in the male only, may be reduced in size or even obsolete.

Frontal. On each side of the frontal stripe, a row of bristles descends from below the ocelli to the base of the antennae, whence the rows usually diverge for a short distance.

Fronto-orbital. Below the outer vertical and above the frontal, near the eye-margin, there is a reclinate bristle. On the female only there are, besides this, two further bristles placed lower, these form a line of three bristles parallel to the eye-margin.

Vibrissa. A pair of long, stout bristles situated near the oral margin and excessively long in comparison with the other bristles around them.

Facial. A series of bristles, small and often hair-like, extending upwards from each vibrissa. A second, or part of a second, row is present but only the number of bristles in the longer row is quoted herein.

Oral. A series of bristles passing from each vibrissa along the oral margin and often contrasting with the hairs around them but sometimes not so easily detected. We have followed the policy of counting these bristles only when they are black.

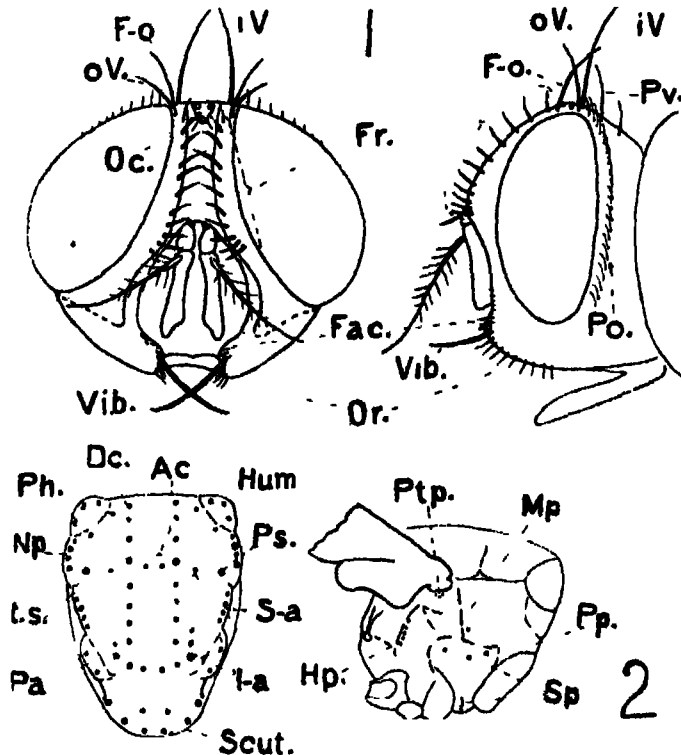
Post-ocular. Immediately behind, and parallel to, the eyes there is a row of black bristles often referred to as *post-orbital*. Sometimes the hairs behind this series form one or two parallel rows of black bristles, these extra rows being apparently constant when they occur on a species and forming one of the leading clues to the identity of females.

Post-vertical: Two pairs of bristles situated behind the verticals.

(13) The terms used for the bristles on the thorax are as follows -

Humeral Three bristles inserted on the humeral callus. The unique *S bancrofti* contains a fourth, but this character is paralleled by a bristle-like hair occasionally seen in isolated cases on other species and, therefore, we do not consider *S bancrofti* to be normal in this respect.

Post-humeral Two bristles situated on the area immediately adjacent to the humeral callus.



Text-fig 1 Diagram of the head

Fac facial, *F-o* frontal orbital, *Fr* frontal, *iV* inner vertical, *Oc* ocellus on which the ocellar bristles occur, *Or* oral, *oV.* outer vertical, *Po* postocular, *Pv* postvertical; *Vib* vibrissa

Text-fig 2 Diagram of the thorax

Ac acrostichal, *Dc.* dorsocentral, *Hp* hypopleural, *Hum* humeral; *I-a.* intra-alar, *Mp* mesopleural, *Np.* notopleural, *Pa.* post-alar, *Ph* post-humeral, *Pp* propleural, *Ps* presutural, *Ptp* pteropleural, *S-a* supra-alar; *Scut.* scutellar; *Sp* sternopleural, *ts* transverse suture

Notopleural. Four bristles alternately short and long, situated immediately above the dorsopleural suture, between the humeral callus and the base of the wing

Presutural A rather strong bristle situated immediately before the trans-

verse suture and above the notopleural bristles. A little beyond this may be another smaller bristle, in a line with the intra-alars, but we prefer to consider this second bristle as one of the intra-alars rather than a second presutural.

Supra-alar Immediately above the base of the wing are four bristles, the fourth sometimes small or even minute, but invariably indicated.

Intra-alar Two or more bristles parallel to the supra-alars, but further from the base of the wing, appear to be of some specific value. A third bristle is often present, and even a fourth may occur, but situated anteriorly to the transverse suture (*see* presutural).

Post-alar Two bristles situated on the post-alar callus.

Dorsocentral Reaching from just behind the head to the scutellum there is a complete row of bristles, of which four at least are situated between the transverse suture and the scutellum in the genus *Sarcophaga*, and only three in the genus *Helicobia*.

Acrostichal Between the two dorsocentral rows, vestiges of two further rows may be traced. These bristles, when present, just anterior to the transverse suture, are termed *presutural*, and those just anterior to the scutellum are *pre-scutellar*. The presence or absence of bristles in these particular positions is of considerable specific importance.

Scutellar On the scutellum there are four pairs of bristles in the male and three in the female.

Propleural Two bristles situated immediately above the anterior coxa.

Mesopleural A row of five bristles along the mesopleural suture.

Sternopleural Three bristles arranged in a row (111) on the sclerite anterior and adjacent to the intermediate coxa. Also between the anterior and intermediate legs a row similar in appearance to those on the anterior and intermediate coxa.

Pteropleural A group of about three bristles just below the wing.

Hypopleural A vertical row of slender bristles just above the hind coxa.

(C) The bristles on the abdomen are as follows —

On the first segment there are *discal* bristles situated on each side, varying in number from one to about eight or more and not particularly constant on any one species, but a more or less useful character is to be found in the manner in which they are arranged. They form one or two distinct rows, each composed of one or several bristles. When they are considerably reduced in number, one row may be eliminated on a species that normally has two rows, this reduction is seldom found on both sides of the insect, so that when a second row is not detected on one side it may be indicated on the other. Besides these discal bristles there are from one to three *submarginal* bristles placed near them.

The second segment is generally provided with from one to three *lateral submarginals*. In *S. howensis* (from Lord Howe Island) alone, of all species of *Sarcophaga* known to us, there is also a median pair of submarginal bristles strongly developed and equivalent to those occurring on the third segment of this and all other species of the genus. The lateral submarginals may be small or even obsolete on the female.

The third segment has a median pair of submarginal bristles, and from one to three laterals on each side. These median and lateral submarginals may be joined by intermediate bristles, making up to six pairs of submarginals similar to those on the fourth segment.

The fourth segment has five, or more usually six, pairs of submarginals on the dorsal side. Except between the median pair, these alternate with *marginal bristles* that may be small and hair-like or may be strongly developed, although not so stout as the submarginals. These marginals continue ventrally, where they are densely massed and often excessively long and slender,

(D) The bristles on the legs are referred to as follows

The femur is more or less oval in cross-section and that flattened surface that faces the head when the legs are at right angles to the body is called the *anterior side*. The other three sides are respectively *dorsal*, *posterior* and *ventral*.

The anterior femur is without bristles on the anterior side and has a row on each of the other three.

The intermediate femur normally has one anterior row, one posterior row which is restricted to one, two or three subapical bristles, and two ventral rows between which, when reflexed, the tibia lies.

The posterior femur has bristles similar to those on the intermediate femur with the addition of a dorsal row.

The bristles on the female femora are generally fewer in number within each row than those on the male, otherwise the variations from the normal that occur in the male will usually be found occurring in the female. It should be noted that where a row on the male is represented by only one or two bristles, in the female it may be obsolete.

The relative lengths of pubescence, short hair and long hair are illustrated in Text-fig 4.

Method of pinning specimens and setting the male genitalia

The method we have adopted in setting Sarcophagid flies is to use a small fine pin passed through the thorax behind the transverse suture and well in front of the scutellum. In this manner the acrostichal bristles remain undamaged and are readily perceptible if present. The insect, if a female, is then "staged".

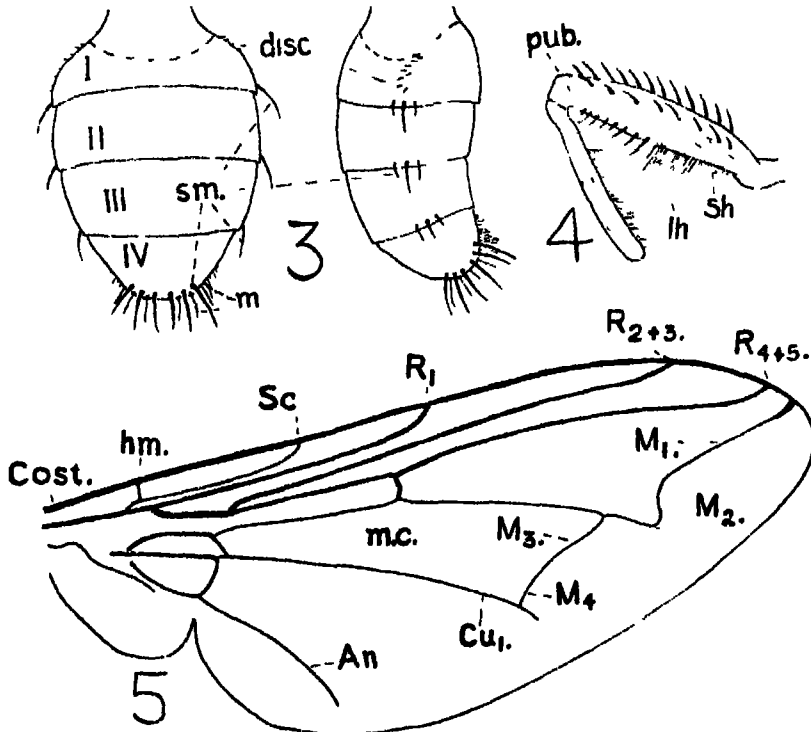
The small pin referred to plays an important part when extracting the male genitalia. It allows the insect to be placed sideways with the genital segments lying close to the cork to which the insect is pinned. A second pin is placed in the cork just above the tip of the abdomen so as to give rigidity and then the genital organs are exposed by inserting the point of another pin against the forceps and drawing them outwards. With fresh material the penis will readily fall into position but with some relaxed specimens a further pin will be necessary to keep the organ in place.

To bring about relaxation we dip the tip of the abdomen into distilled water heated just below boiling point. We find that although the wings may be slightly damaged, especially near the tip the insect retains its colour and form far more satisfactorily than is usually the case with those relaxed slowly by the more general methods. The time taken to relax by our method is usually half a minute but depends upon the age of the specimen, some very old ones taking quite a minute.

Method of examining and drawing the genital parts

In examining the type specimens and drawing the genital parts, we have utilised a Leitz-Greenough Stereoscopic Binocular Microscope with eye-pieces O-V, and objectives 25 and 48 mm. The parts of the penis are so very small that it

is necessary to have a stereoscopic effect in order to understand them. We have found it advantageous to examine the organ under higher powers in the direct sunlight, at the same time reflecting the rays with a concave mirror on to the object thus illuminating the inside as well as the outside of the genital complex.



Text-fig 3 Diagram of the abdomen

I-IV 1st to 4th segments, *disc* discal, *sm* submarginal, *m* marginal

The median pair of submarginal bristles on the third segment have been accidentally omitted in the drawing

Text-fig 4 Diagram of the posterior femur and tibia

lh long hair, *pub* pubescence, *sh* short hair

Text-fig 5 Diagram of the wing

The veins are named in rotation as follows—*Cost* the costa which, bordering the wing, reaches to near the apex, *hm* humeral, a small cross vein, *Sc* subcosta, *R*₁ first radial, *R*₂₊₃ second and third radials united, *R*₄₊₅ fourth and fifth radials united; *M*₁ first median, *M*₂ second median; *M*₃ and *M*₄ third and fourth median veins respectively, the basal portion is obsolete thus leaving these two remnants acting as a cross vein between the first median and the cubital vein, *Cu*₁ first cubital which unites with *M*₄ at its apex, *An* anal, *mc* median cell

By this method we have been able to trace the actual outline of each part of the penis to its source and in a few cases we have augmented our studies by

microslides made from specimens other than the types. The genital parts were drawn in outline by the aid of a camera lucida and the lines not visible by this method were drawn in freehand.

In order to show the relative shape of the various parts more than one view of the penis has been drawn. In each case the usual lateral view is given and another aspect such as the ventral or anterior side supplements it. A ventral view, correctly given, would sometimes hide an important aspect of the organ, so in such cases a drawing is made from a more or less tilted position.

Explanation of terms used when describing the male genitalia

In studying the genital parts we have found a set of characters that occur in the majority of species and are constant in outline and design within each species. In the case of the penis we have had to select terms in order that these parts may be described.

Forceps. A pair of appendages that protect the genital opening when the penis is withdrawn.

Claspers. On each side of the penis there is a pair of pointed and forwardly directed processes, the first of which is called the *anterior*, the hinder the *posterior* clasper. The anterior clasper is movable in a longitudinal, and the posterior in a lateral direction.

First joint of the penis. The basal joint.

Second joint of the penis. The apical joint, which is very complex, contains the following parts—

Anterior appendage. Often large and consisting of one, sometimes two, pairs of flanges that vary greatly in size and shape in the various species.

Lobe. On each side of the main and enveloping portion of the penis is a flange that is often lobe-like and sometimes forms a conspicuous process.

Lateral process. Situated beyond the lobe is a pair of forwardly directed processes, always conspicuously separated at the base and never contiguous.

Apical process. An extension of the apex if present, is referred to by this term. It may consist of an unpaired process or a pair of closely adjacent parts. Extra processes may also be present, but are not usual.

Interior process. A term given to a process arising internally from just posterior to each lobe, so far this process has only been detected in *S. peregrina* Deav. and *S. kappa* J and T.

Filaments. Between the anterior appendage and the main enveloping portion of the penis there may exist a further pair of appendages referred to by this name. They can be seen arising from the base of the joint and are generally filamentous, although in one species, *S. securifera* Villen., they appear to be highly modified at the apex. Filaments are not always observable and as far as we have determined do not exist in species where they are not apparent.

Variation in the size of species

One of the commonest species of Sarcophagid flies around Brisbane is *S. tryoni* and of this we have bred over one hundred and fifty specimens, from at least ten females, during four months. One captured female, a very large specimen, produced a batch of flies, all of which were of a large size, about 12 mm. in length. Another, a small female, the identity of which was not known at the time of capture, produced a batch of flies ranging from 6 mm to about 9 mm.

These two batches, as far as we could tell, were bred under similar conditions and were bred out within a week of each other, consequently it seems possible that size may be an hereditary character quite apart from food. We have other species, varying in size, but not quite reaching the extremes found in *S tryoni*, nevertheless there is sufficient to show that dimensions are too unstable a character for specific determination. *S omega* and *S eta* range from 7 to 12 mm in the various collections examined.

It is significant to note that the chaetotaxy varied remarkably little in the smaller and larger batches of *S tryoni* that were bred, and it agrees closely with that of captured specimens.

Genus *SARCOPHAGA* Meigen

Definition—The arista is strongly plumose on the basal half and bare thence to the apex. Eyes bare. Thorax with three distinct black stripes. The second humeral bristle situated in a line with or above the presutural. At least four post-sutural dorsocentral bristles. Abdomen tessellated with silvery and black tomentum. Wings without bristles on the vein R_1 , and with a few at the base of R_{4+5} . The vein M_1 , at half its length, bends sharply upwards whence, for a short distance, it proceeds at right angles to the basal part, thence, diverging, reaches the costa before the apex of the wing and near the apex of the vein R_{4+5} . The venation is illustrated and explained in Text-fig. 5.

Observations—The above definition will be sufficient to distinguish species of the genus *Sarcophaga*, as recognised by us, from other genera of Sarcophagid flies known to us and also from the numerous flies which, although belonging to distinct groups, have a very striking resemblance to these. Further characters have been given under the discussion on the chaetotaxy.

Under the above definition will come also many of the species that have been made the types of other genera, thirty-nine of which were diagnosed in key form by Townsend in 1917. We have attempted to place our Australian species into groups in accordance with Townsend's key, but have found that, in such an attempt, species that, according to genitalia, must be considered closely allied, were widely separated.

In more recent literature several genera have been proposed to contain groups of species that have closely allied genital characters and it is on this principle that ultimate success in re-grouping the Sarcophagid flies will probably be attained.

Sarcophaga alpha, *S eta*, *S beta* and *S howensis*, to which also may be added (at least for the time being) *S tryoni*, *S impatiens* and even perhaps *S epsilon*, form one group. All these have a well developed flange on the anterior clasper which in the case of the first four becomes bifid. All except the last-named have also a very strongly developed pair of forceps.

S misera, *S kohia* and perhaps *aurifrons*, *omega* and *eta* will form a second group. Each has a pair of well developed lateral processes which are bifid in the first two species.

S bancrofti and *S fergusoni* will form yet another group, whilst the remaining species have their genitalia too diverse in structure to permit of their being readily grouped in this manner.

A study of the nearest allies within these groups shows that an attempt to use chaetotaxy as a guide to affinities would be misleading.

Key to the species of Australian flies of the genus Sarcophaga based upon the male genital characters

1. Genital segments red *securifera* Villen
Genital segments black 2
- 2 Anterior clasper bifid or with a very wide flange 3
Anterior clasper simple, or if a flange be present then it does
not exceed the width of the clasper 9
- 3 Anterior clasper bifid and with a knob anterior to it 4
Anterior clasper not bifid and without a knob anterior to it 6
- 4 Filaments present 5
Filaments absent *zeta* J & T
- 5 Anterior clasper bifid nearly to its base *alpha* J & T
Anterior clasper bifid for only half its length *beta* J & T
- 6 Filaments present 7
Filaments absent *tryoni* J & T
- 7 Forceps large, seen laterally curved and with a conspicuous angle at two-thirds its length Apex of the anterior appendage with a conspicuous forwardly directed "hook" *impatiens* Walk
Forceps of moderate length and not angulated Anterior appendage without a hook 8
- 8 Anterior appendage and lobe very small Lateral and apical processes together forming a complex tapering and forwardly directed termination to the penis *epsilon* J & T
Anterior appendage large and expanding Lobe produced to a pointed apex Lateral process small and curved under a wide, lateral flange on the apical process *hardyi* J & T
- 9 Lateral process present 10
Lateral process absent 18
- 10 A pair of knobs situated behind the lateral processes which are very complex *omikron* J & T
Without such knobs 11
- 11 Lateral process bifid towards the tip 12
Lateral process simple 13
- 12 Anterior appendage composed of one pair of broad flanges *misera* Walk
Anterior appendage composed of two pairs of narrow flanges *kohla*, n sp
- 13 With an apical process 14
Without an apical process 16
- 14 Apex of the anterior appendage produced into an extremely long process directed downwards *eta* J & T
Anterior appendage without such a process 15
- 15 Anterior appendage broad and much of its area consisting of a mass of minute spines *peregrina* R D
Anterior appendage slender and scarcely discernible when the penis is seen laterally *depressa* R D
- 16 Filaments present *aurifrons* Macq
Filaments absent 17
- 17 Lateral process long, lobe long and pointed anterior clasper conspicuously longer than the posterior *omega* J & T
Lateral process short, lobe inconspicuous, claspers of about equal length *froggatti* Taylor
- 18 Filaments present 19
Filaments absent 20
- 19 Apex of the forceps minutely bifid Anterior clasper with a small flange at the extreme apex The pair of anterior appendages slender and bowed, almost meeting at the apex *synia*, n sp

- Apex of the forceps simple Anterior clasper much longer than the posterior and without a flange at the apex Anterior appendage widely expanding and broad *gamma* J & T
- 20 Apical process paired (i.e. consisting of two contiguous processes) 21
- Apical process not paired *fergusoni* J & T
- 21 Anterior appendage doubled back, so that the apex is directed towards the base *bancrofti* J & T
- Anterior appendage directed downwards in the usual manner 22
- 22 Claspers of about equal length A pair of interior appendages protrude slightly beyond the apical appendages *kappa* J & T
- Anterior clasper longer than the posterior Without interior appendages *hittorali* J & T

Alternative key to the male flies of the genus Sarcophaga

- 1 Genital segments red *securifera* Villen
- Genital segments black 2
- 2 With one row of bristles behind the eyes 3
- With two rows of bristles behind the eyes 18
- With three rows of bristles behind the eyes 19
- 3 With long hair on the posterior tibiae 4
- Without long hair on the posterior tibiae 13
- 4 With prescutellar acrostichal bristles 5
- Without prescutellar acrostichal bristles, with presutural acrostichals *tryoni* J & T
- 5 With two rows of ventral bristles on posterior femur 6
- With one row of ventral bristles on posterior femur 10
- 6 Long hair on posterior tibia abundant 7
- Long hair on posterior tibia scanty *zeta* J & T
- 7 With one row of disco-lateral bristles on first abdominal segment 8
- With two rows of disco-lateral bristles on first abdominal segment *impatiens* Walk
- 8 Species with golden yellow tomentum on head and thorax 9
- Species with silvery-grey tomentum on head and thorax *hardyi* J & T
- 9 Third joint of the antennae about three times the length of the second *alpha* J & T
- Third joint of the antennae about twice the length of the second *beta* J & T
- 10 The marginal bristles on the fourth abdominal segment strongly developed almost as long as the submarginals 11
- The marginal bristles on the fourth abdominal segment weak or obsolete *kappa* J & T
- 11 Third antennal joint about three times the length of the second *omikron* J & T
- Third antennal joint about twice the length of the second 12
- 12 Outer vertical bristles absent, or at most as long as the post-oculars *omega* J & T
- Outer vertical bristles twice the length of the post-oculars *gamma* J & T
- 13 With prescutellar acrostichals 14
- Without prescutellar acrostichals *froggathi* Tavior
- 14 With presutural acrostichals 15
- Without presutural acrostichals *musca* Walk
- 15 With two extremely long bristles at about half the length of second ventral row on intermediate femur Ventral hairs on abdomen unusually long *depressa* R D

- Bristles of second ventral row on intermediate femur of about equal length
littoralis J & T
- 16 With long hair on the posterior tibiae 17
 Without long hair on the posterior tibiae *bancrofti* J & T
- 17 With two rows of ventral bristles on intermediate and posterior femora 18
 With one row of ventral bristles on intermediate and posterior femora
eta J & T
- 18 Ventral hair of abdomen short and scanty *kohla*, n sp
 Ventral hair of abdomen rather long and dense *fergusoni* J & T
- 19 With prescutellar acrostichals, without long hairs on posterior tibiae 20
 Without prescutellar acrostichals, with long hairs on posterior tibiae
epsilon J & T
- 20 With one row of ventral bristles on intermediate and posterior femora 21
 With two rows of ventral bristles on intermediate and posterior femora
aurifrons Macq
- 21 With presutural acrostichals *syna*, n sp
 Without presutural acrostichals *peregrina* R D

Key to the female flies of the genus Sarcophaga

- 1 Genital segments red *securifera*
 Genital segments black or brown 2
- 2 With one row of postocular bristles 3
 With two (or more) rows of postoculars 8
- 3 With presutural acrostichal bristles 4
 Without presutural acrostichals, with golden yellow tomentum behind the eyes *miseria*
- 4 With prescutellar acrostichals 5
 Without prescutellar acrostichals 7
- 5 With one row of disco-lateral bristles on the first abdominal segment 6
 With two rows of disco-laterals on first abdominal segment, with golden yellow tomentum behind the eyes *impatiens*, *kappa*, *omega*.
- 6 With golden yellow tomentum behind the eyes *beta*, *depressa*, *omikron*
 With silver grey tomentum behind the eyes *hardyi*, *littoralis*
- 7 With three postsutural intra-alar bristles *tryoni* *
 With two postsutural intra-alars *froggath*
- 8 With presutural acrostichals, with silver grey tomentum behind the eyes *peregrina*
 Without presutural acrostichals 9
- 9 With golden yellow tomentum behind the eyes *aurifrons*.
 With silver-grey tomentum behind the eyes *eta*.

In choosing a set of characters whereby any female specimen can be relegated to its correct species, we have been confronted with several difficulties. The females of many species are not certainly known to us, and in only a few cases have we a sufficiently large number that have been correctly referred to their respective males either by breeding or by having been taken in copula. Moreover, there appear to be several cases where the identification label has been transferred on specimens previously studied, thus causing confusion in regard to the limits of variation within the species.

*Since this key was prepared further specimens of *S tryoni* have been bred and many of them are without the third intra-alar bristle.

Of the twenty-two species recorded from Australia, the females of seven are unknown, seven are isolated in the above key, and eight are further grouped into three groups not containing more than three species each. We believe a little modification of the scheme here outlined, when amplified by other characters that may be discovered by a critical survey of females, will ultimately lead to the compilation of a key that will permit the ready determination of the species from the female sex.

SARCOPHAGA ALPHA Johnston and Tiegs (Text-fig 6)

Sarcophaga alpha, Johnston and Tiegs, Proc Roy Soc. Queensland, xxxiii, 1921, p 57, fig 21, Rec Austr Mus, xiii, 1922, p 177

Synonymy—The illustration given by Bottecher, when describing his *S antiops* (a species from Formosa and New Guinea), has much in common with *S alpha* and we consider it possible that the two may ultimately be found to belong to one species. The penis in Bottecher's figure does not quite conform to our illustration although the essential characters are there.

Description—♂ **Head** Outer vertical bristles about twice the length of the post-oculars, twelve frontals, two or three facials, nine orals, one row of post-oculars

Thorax Two intra-alar, one small pair of presutural, and two large pairs of prescutellar acrostichals

Abdomen On the first segment one row of two discal lateral bristles and one submarginal, an extra submarginal is developed on one side in the holotype. On the second, one lateral submarginal and an extra one on one side in the holotype. On the third, one median pair and three lateral submarginals. On the fourth segment six pairs of submarginals alternating with marginals

Genitalia Forceps long and strongly curved. The anterior clasper bifid almost to the base, and anterior to this there is a small knob, the posterior clasper is broader than the anterior but about the same length. Anterior appendage rather broad and simple, apical process tapering, but moderately broad and rounded at the apex, filaments very long

Legs The chaetotaxy conforms to the general type, long hair is abundant on all the femora and on posterior tibiae

Hab—Queensland

Observations—The above description is taken from the holotype specimen in the Queensland Museum. By slightly altering the position of the parts and allowing for the more forwardly placed filaments, an outline of the genitalia very similar to that given by Bottecher from his *S antiops* can be seen on the holotype of *S alpha*.

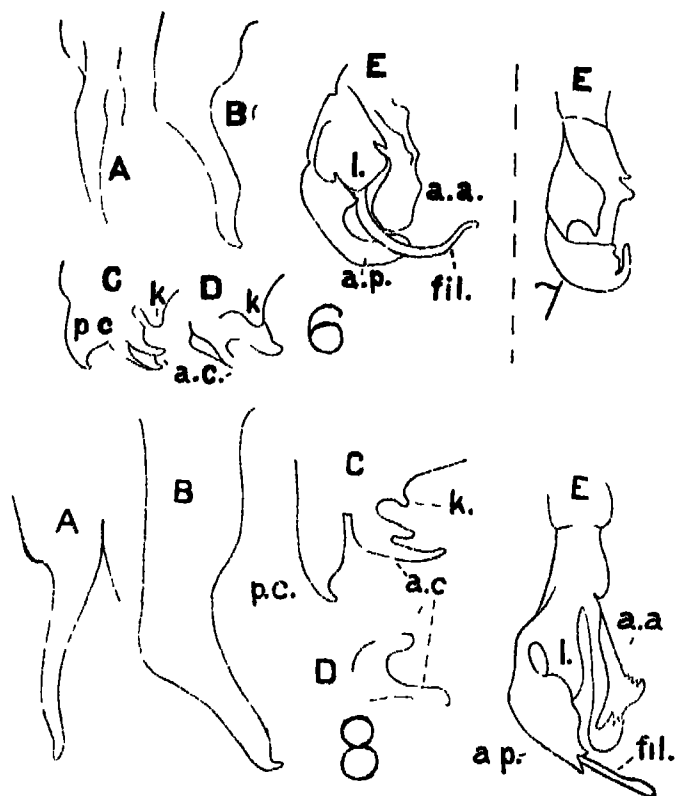
SARCOPHAGA ZETA Johnston and Tiegs (Text-fig 7)

Sarcophaga zeta, Johnston and Tiegs, Proc Roy Soc Queensland, xxxiii, 1921, p 76, fig 20; Also xxxiv, 1922, p 183, Rec Austr Mus, xiii, 1922, p 180

Description—♂ **Head** Outer vertical bristles inconspicuous, as long as the post-oculars; thirteen frontals, eight or more facials; about five orals, one row of post-oculars

Thorax Two intra-alar bristles; presutural and prescutellar acrostichals present

Abdomen On the first segment a row of two discal lateral bristles and one submarginal. On the second, one lateral submarginal. On the third, one median pair and two lateral submarginals. On the fourth segment the bristles conform to those on *S. alpha*, but this cannot be detected on the holotype as the segment is broken.

Text-fig 6 *Sarcophaga alpha* J & TText-fig 7 *Sarcophaga zeta* J & TText-fig 8 *Sarcophaga beta* J & T

The following letters occurring in the above and all subsequent illustrations indicate the names of the various parts.--

A Forceps or the apical part of them seen posteriorly, B The same, lateral view, C Claspers, D Another aspect of one or both the claspers, E Second joint of the penis seen laterally, F. The same, ventral view, G The same, or its apex seen posteriorly, H The same, seen anteriorly, I Second joint of the penis, or part of it drawn from another specimen belonging to the same species.

Claspers a.c. anterior clasper, p.c. posterior clasper, k knob

Penis a.a. anterior appendage, a.p. apical process, fil. filaments, i.p. interior process; k knob, l lobe, l.p. lateral process

Genitalia Forceps and claspers identical with those of *S. alpha*. Anterior appendage enfolded by the remainder of the second joint of the penis which has a pair of slender apical processes, filaments absent.

Legs. The chaetotaxy conforms to the general type but the second ventral row on the posterior femur is weak. The femora are scantily clothed with long hair, the majority being found on the anterior femur, hairs on the posterior tibiae are also scanty.

Hab—Queensland

Observations—The above description is based upon the holotype specimen in the Queensland Museum. In order to test the structure of the penis we relaxed a paratype specimen and could find no sign of the filaments. At the same time we found that, when relaxed, the posterior clasper was movable in a lateral direction and the anterior clasper was hinged to move backwards, so that the three apices of the claspers were brought into one line, in which position they were allowed to dry on one side. The position was secured again on a fresh specimen and with remarkable ease, the two claspers falling into place as readily as they had done in the relaxed specimen.

SARCOPHAGA BETA Johnston and Tiegs. (Text-fig 8)

Sarcophaga beta, Johnston and Tiegs, Proc Roy Soc Queensland, xxxiii, 1921, p 58, fig 6, Rec Austr Mus, xiii, 1922, p 177—*S. delta*, Johnston and Tiegs, *ibidem*, xxviii, 1921, p 62, fig 13.

Synonymy—*Sarcophaga delta* was described from a single male and the penis is doubled back, somewhat distorting the parts, but we have given this a more critical examination, as the other parts of the genitalia were found to be identical with those of *S. beta*. As the parts of the penis are essentially the same in the holotypes of these two species we consider that they cannot be maintained as separate species.

Description—♂ **Head** Outer verticals about as long as the post-oculars, on the holotype of *S. beta* there are nine frontals on one side and twelve on the other, and on *S. delta* ten on each side, facials seven or eight, orals seven, and on *S. delta* this row is doubled, that is, there are two rows of about seven each, one row of post-oculars.

Thorax Intra-alai bristles two (*S. beta*) or three (*S. delta*). Owing to damage, on the thorax only prescutellar acrostichals are discernible on the holotypes, but presutural acrostichals are also present on other specimens.

Abdomen On the first segment one row of four (*S. beta*) or five (*S. delta*) discal laterals, and one submarginal. On the second, two lateral submarginals. On the third, one median pair and two lateral submarginals. On the fourth segment five pairs of submarginals.

Genitalia. The forceps, claspers and the knob are not very different from those on *S. alpha*, but the anterior clasper is bifid for only half its length. The anterior appendage contains a very delicate fringe that is not easily detected, owing to the lack of chitination on the fringed parts, apical process rather broad; filaments very long. These genital parts are very similar to those of *S. howensis* Johnston and Hardy, from which they differ only in the apex of the second joint of the penis.

Legs The chaetotaxy conforms to the general type, but with the addition of two subapical bristles representing a second dorsal row on the posterior femur. Long hair occurs on all femora and on posterior tibiae.

♀ The chaetotaxy of the female corresponds remarkably well after allowance is made for sexual differences. There are twelve frontal bristles on each side.

Hab -- Queensland

Observations -- The above description is taken from the holotype specimens of *S. beta* and *S. delta*, and the allotype of *S. beta*, all of which are in the Queensland Museum. A further series of specimens has been examined by us including eight males, the variations in chaetotaxy cover those of the two holotypes, but we have not been able to detect within the series corresponding differences in the male genitalia.

The species *alpha*, *seta*, *howensis* and *beta* have many genital characters in common, the bifid anterior clasper with the curious knob anterior to it, the long forceps conspicuously bent at two-thirds their length, the small lobe, and the absence of the lateral process do not exhaust the points of similarity. The forceps are raised upon a tubercle that is very prominent in comparison with the corresponding structure on other species. This combination of characters appears to point to very close affinities and it is significant to note that one species, *S. howensis*, has the abnormal character of a pair of median submarginal bristles on the second abdominal segment, which indicates that outstanding characters in chaetotaxy cannot be used advantageously to form natural groups within the genus *Sarcophaga*.

SARCOPHAGA TRYONI Johnston and Tiegs (Text-fig 9)

Sarcophaga tryoni, Johnston and Tiegs, Proc Roy Soc Queensland, xxxiii., 1921, p. 54, figs 9-10, Rec Austr Mus, xiii, 1922, p. 176 -- *S. queenslandae*, Parker, Canadian Entom., liv, 1922, p. 6, figs 1-2.

Synonymy -- Mr R. R. Parker informs us that his species *S. queenslandae* is the same as *S. tryoni*.

Description -- ♂ *Head*. Outer verticals slightly longer than post-oculars, twelve frontals on one side, thirteen on the other, one strong and several small facials, about seven oials, one row of post-oculars.

Thorax. Two intra-alars on one side, three on the other, and a further one placed anteriorly to the suture is also present. Only the presutural acrostichals present.

Abdomen. On the first segment one row of four or more discal lateral bristles and one submarginal. On the second, one lateral submarginal. On the third, one median pair and two lateral submarginals. On the fourth segment six pairs of submarginals.

Genitalia. Forceps long. Anterior clasper with a very broad flange. Anterior appendage formed of two parts, the lower of which contains a small but distinct process on the ventral edge, lobe pointed; lateral process barely indicated by a small pointed projection just above the lobe, a pair of apical processes, each containing three pointed projections.

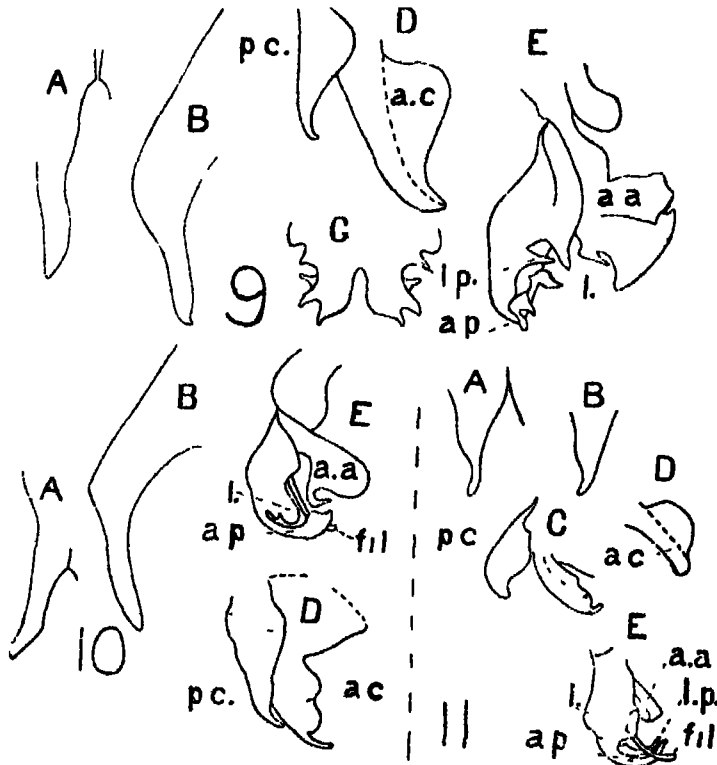
Legs. The chaetotaxy conforms to the general type, but the second ventral row on the posterior femur is represented by three or four subapical bristles only. Long hair occurs scantily on the anterior and posterior femora and abundantly on the posterior tibiae.

♀ The chaetotaxy of the female corresponds well with that of the male, after allowance is made for sexual differences; the submarginal lateral bristle on

the first abdominal segment is missing and the second ventral row on the posterior femur is well indicated.

Hab—Queensland

Observations—On re-examining the material in the Queensland Museum we discovered that the holotype label had been attached to a female specimen, so we have transferred this to the specimen from which the "figure 9" of the original drawings was made. The above description is taken from this newly selected holotype and the allotype, both of which are in the Queensland Museum. Over two hundred specimens have been examined by us, and it appears that the



Text-fig 9 *Sarcophaga tryoni* J & T

Text-fig 10 *Sarcophaga impatiens* Walker

Text-fig. 11 *Sarcophaga epsilon* J & T

absence of prescutellar bristles, together with one row of post-oculars and three post-sutural intra-alar bristles are characters ample for the determination of this species from either sex.

SARCOPHAGA IMPATIENS Walker (Text-fig 10)

Sarcophaga impatiens, Walker, Last Dipt Brit Mus, iv, 1849, p 828; Johnston and Tiede, Proc Roy. Soc Queensland, xxxiii, 1921, p 52, figs 18-19, Also xxxiv, 1922, p 182, Rec. Austr Mus, xiii, 1922, p 176

Status—A female specimen was compared by Major E. E. Austen with the holotype female in the British Museum. Bred specimens were determined as belonging to the same species as that compared with the type and the male was described for the first time by Johnston and Tiegs in 1922.

It is significant to note that where, in the compared female, there is only one row of disco-lateral bristles on the first abdominal segment, in that of the described male and in both sexes of other bred specimens there are two rows. These bristles are very well developed, so it excludes the possibility of the second row being reduced on the compared specimen. It seems possible that the compared female belongs to the species known to us as *S. alpha*, but a further study of females, including that of Walker's type specimen, is necessary before any finality can be reached concerning the true identity of Walker's species.

Description—♂ *Head*. Outer verticals slightly longer than post-oculars, frontals twelve on one side, thirteen on the other, facials two, beyond which there is a line of about ten hairs, four orals, one row of post-oculars.

Thorax. Two intra-alars and a third anterior to the transverse suture, precutular and prescutellar acrostichals present.

Abdomen. On the first segment two rows of five or six discal laterals, and one strong and one weak submarginal. On the second, one strong and one weak lateral submarginal. On the third, one median pair and three lateral submarginals. On the fourth segment six pairs of submarginals.

Genitalia. Forceps long. Anterior clasper with a broad flange, both claspers of about equal length. The apex of the anterior appendage with a conspicuous, forwardly directed, hook-like process that is characteristic of the species, the apical process paired, the lobe is very distinct, filaments present, projecting just beyond the apex.

Legs. The chaetotaxy conforms to the general type, but with the addition of a second dorsal row represented by two adjacent bristles at about two-thirds the length on the posterior femur, and the second ventral row consists of weak bristles. Long hair occurs on all femora and on posterior tibiae.

♀ Eleven frontals on one side, twelve on the other, one long stout facial and about five further small ones, one or two stout orals and three or four hair-like ones. A single row of four or five strongly developed disco-laterals. In other respects the chaetotaxy conforms to that of the male.

Hab—Queensland, New South Wales, Tasmania.

Observations—The above description is taken from the allotype male and from the female that was compared by Major Austen with the holotype female in the British Museum. As pointed out above, these very probably represent two species, and it is impossible at present to determine which, if either, belongs to the true *S. impatiens* of Walker.

The female of *S. impatiens* that was described by Johnston and Tiegs has characters corresponding to the allotype male and in our key to females we have ignored the characters of Major Austen's compared female, we leave the true identity of the species for further consideration. If the characters of the compared specimen were taken into account, then the female would come into the *beta-omikron* group of the key.

SARCOPHAGA EPSILON Johnston and Tiegs (Text-fig 11)

Sarcophaga epsilon, Johnston and Tiegs, Rec. Austr. Mus., xiii, 1922, p. 180, fig. 1

Description—♂ **Head** Outer vertical bristles slightly longer than the post-oculars, twelve frontals, two strong and four short facials, eleven orals, beyond which there is a line of bristle-like hairs, three rows of post-oculars.

Thorax Two intra-alai bristles, acrostichals absent (the thorax is badly denuded on the holotype but two other specimens examined show that the acrostichals are absent, or, if present, not discernible from the hair, which is rather long and plentiful on this species).

Abdomen On the first segment one row of five discal lateral bristles and three submarginals. On the second, two lateral submarginals. On the third, one median pair and three lateral submarginals. On the fourth segment six pairs of submarginals.

Genitalia Forceps slightly curved. Anterior clasper with a well developed flange, the two claspers of about the same length. Anterior appendage very small and simple, lobe interiorly defined, lateral process probably represented by a pair of appendages that lie close to the equally long apical process, filaments long.

Legs The chaetotaxy differs from the general type by the absence of the second ventral row on the posterior femur. Long hairs occur scantily on the anterior femur and posterior tibiae.

Hab—Queensland, New South Wales. 2 ♂♂, Collaroy, Sept., 1921.

Observations—The description is taken from the holotype male in the Australian Museum.

SARCOPHAGA HARDYI Johnston and Tiegs (Text-fig 12)

Sarcophaga hardyi, Johnston and Tiegs, Rec. Austr. Mus., xiii, 1922, p. 180, Pl. xxxv, fig. 5.

Description—♂ **Head** Outer verticals about the length of the post-oculars, frontals eleven on one side, twelve on the other, two rows of about seven facials, five orals, one row of post-oculars.

Thorax Three intra-alai bristles and a fourth placed presuturally, presutural and prescutellar acrostichals strong.

Abdomen On the first segment one row of three discal lateral bristles and one submarginal. On the second, one lateral submarginal. On the third, one median pair and one lateral submarginal. On the fourth segment, five pairs of submarginals alternating with marginals.

Genitalia Forceps rather short. Anterior clasper longer than posterior and with a short but broad flange near the base. Second joint of the penis composed mostly of thin, uniformly chitinated plates, anterior appendage broad and large, containing an anterior transparent process that is difficult to detect and terminating in a row of spines, lobe produced into a rather long triangular process, lateral process curved under a broad flange situated on the apical process, apical process, besides containing a pair of these flanges, is bifid at the tip, filaments present.

Legs The chaetotaxy conforms to the general type but the second ventral row on the posterior femur is weak. Long hair occurs on all femora and on posterior tibiae.

♀ The chaetotaxy of the female corresponds remarkably well with that of the male, there are ten frontal bristles.

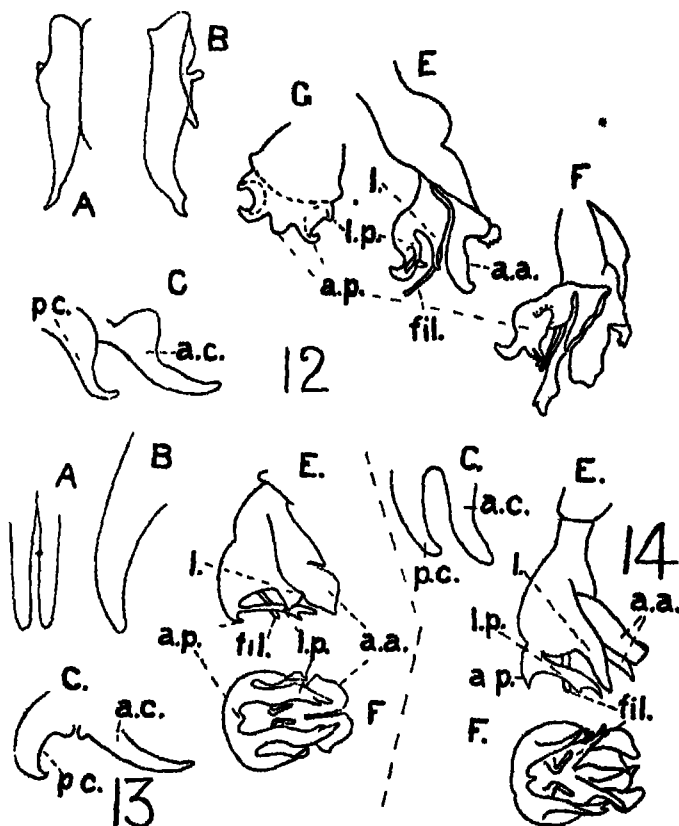
Hab—Tasmania, New South Wales, Kosciusko, two males taken by Dr. E. W. Ferguson, December, 1921.

Observations—The description is taken from the holotype and the allotype in the Australian Museum

SARCOPHAGA MISERA Walker (Text-fig 13)

Sarcophaga misera, Walker, *List Dipt Brit Mus*, iv., 1849, p 849, Johnston and Tiegs, *Proc Roy Soc Queensland*, xxxiii, 1921, p 67, fig 22, *Rec Austr Mus*, xiii, 1922, p 178

Status—Walker's type is a female in the British Museum. Major Austen determined by comparison with the type, two female specimens which are undoubtedly identical with those determined later and described by Johnston and Tiegs under Walker's name



Text-fig 12 *Sarcophaga hardyi* J & T
 Text-fig 13 *Sarcophaga misera* Walker
 Text-fig 14 *Sarcophaga kohla*, n sp

Description—♂ Head Outer vertical bristles scarcely as long as the post-oculars; eleven frontals; four facials, about fourteen orals, one row of post-oculars.

Thorax. Three intra-alar bristles and a fourth placed presuturally, only prescutellar acrostichals present.

Abdomen On the first segment, two discal lateral bristles on one side and two rows of three each on the other, one submarginal lateral. On the second, one lateral submarginal. On the third, one median pair and three lateral submarginals. On the fourth segment, six pairs of submarginals.

Genitalia. Forceps short, simple and slightly curved. The claspers of equal length. Anterior appendage large, broad, lobe pointed at apex, the lateral process long and bifid towards the tip, apical process very small and unpaired, filaments present.

Legs. The chaetotaxy differs from the general type by the absence of the second ventral row on the posterior femur. Long hair on intermediate and posterior femur only.

♀. The chaetotaxy corresponds rather well with that of the male, there are nine frontal bristles.

Hab—Queensland, New South Wales, Victoria, South Australia and Lord Howe Island.

Observations—The above description is taken from the allotype male and the larger of the female specimens that were compared with the holotype female in the British Museum by Austen. We have examined about eighty specimens, the majority of which have been recently bred by us.

SARCOPHAGA KOHLA, n.sp. (Text-fig 14)

Sarcophaga misera var *dux*, Johnston and Tiegs, Proc Roy Soc Queensland, xxxiii., 1921, p. 70, fig. 23; Rec Austr. Mus., xiii, 1922, p. 178.

Synonymy—In a note to Dr E. W. Ferguson, Mr R. R. Parker referred to his *S. subtuberosa* as being synonymous with *S. dux* Thomson and consequently Johnston and Tiegs published this information.

S. misera var *dux*, however, cannot be accepted as identical with *S. sub-tuberosa* Parker or *S. dux* Thomson, as there are too many genital and other differences between them and, on this account, we describe the species under a new name.

Description—♂. **Head.** Outer verticals scarcely longer than the post-oculars, frontals ten on one side, eleven on the other, about four facials, twelve orals, two rows of post-oculars.

Thorax. Three intra-alar bristles and a fourth placed presuturally, prescutellar acrostichals only present.

Abdomen. On the first segment, two rows of strong discal lateral bristles and one submarginal. On the second, one lateral submarginal. On the third, one median pair and two lateral submarginals. On the fourth segment, six pairs of submarginals.

Genitalia. Forceps and claspers similar to those on *S. misera*. The anterior appendage divided into two pairs of more or less equally long and narrow parts, lobe conspicuously more prominent than in *S. misera*; and the bifid lateral process is more slender than the corresponding part on that species; also the apical process is longer and more pointed.

Legs. The chaetotaxy conforms to the general type.* Long hair occurs abundantly on all femora and on posterior tibiae.

Hab—Queensland; New South Wales.

Observations—Described from one of the original specimens referred to by Johnston and Tiesg as *S. misera* var *dux*, and now deposited as holotype in the Australian Museum, Sydney

We have examined the female specimen from Honolulu, together with a male from the same locality that is evidently conspecific with it, these agree far better with *S. misera*, although showing characters in chaetotaxy which, if constant, would easily separate the Australian *S. misera* from the Honolulu specimens of *S. dux*. This pair from Honolulu has the second row of black post-ocular bristles small and considerably thinned out, every alternate one or two bristles being obsolete. Also the penis shows a form approaching *S. misera* in the shorter apical process and the structure of the anterior appendage, the latter approximating that drawn by Parker to illustrate his *S. subtuberosa*.

We have examined five specimens of *S. kohla*, one of which is in the Queensland Museum and two are in Dr Ferguson's collection.

SARCOPHAGA SECURIFERA Villeneuve. (Text-fig 15)

Sarcophaga securifera, Villeneuve, Mitt Zool. Mus. Berlin, iv, p 123, fig., Botteher, Deut. Ent. Zeitsch., 1913, pp 15, 370, fig 41, Aldrich, *Sarcophaga* and allies, 1916, p. 202, fig 95

Description—♂ Head Outer verticals strong, at least twice the length of the post-oculars, frontals from seven to twelve, facials about seven, orals about twelve, one row of post-oculars

Thorax Two intra-alars, acrostichals absent (in male only)

Abdomen On the first segment, one row of discal laterals and one submarginal. On the second, one lateral submarginal. On the third, one median pair and two lateral submarginals. On the fourth segment, five or six pairs of submarginals

Genitalia. Genital segments red. Forceps rather broad. Claspers simple, slender, the anterior longer than the posterior. Anterior appendage small, simple, lobe rather sinuous and pointed, lateral process long and terminating in a small flat semicircular disc, filaments rather complex at the apex, their true nature not having been detected.

Legs The chaetotaxy appears to conform to the general type. Long hair occurs on the anterior femur and on the posterior femur and tibia.

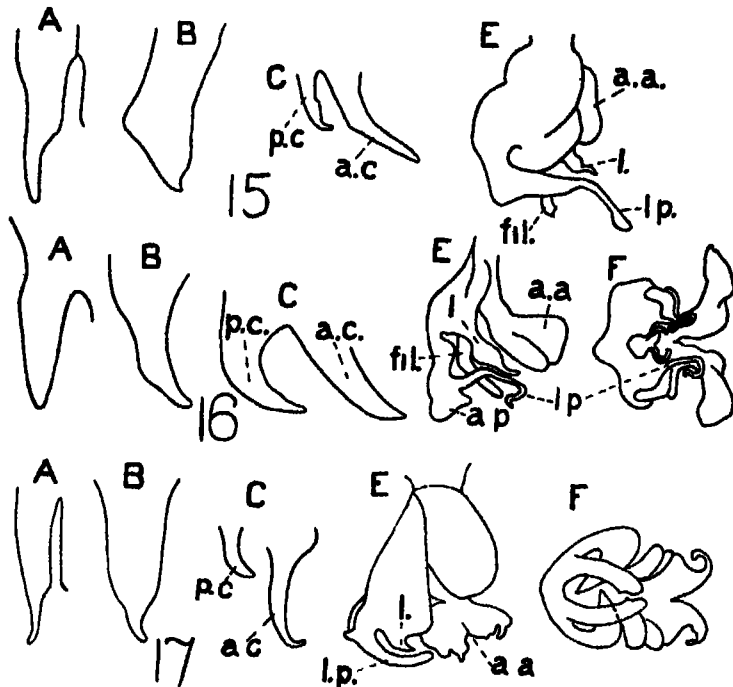
♀ Contrary to the usual rule, this species has several characters on the female that disagree with those on the male. The prescutellar acrostichals are strong and there are two strongly developed rows of discal lateral bristles on the first abdominal segment. The genital segments of the female are red like those of the male, a character that will readily separate the species from all others described in this paper.

Hab—Originally described from the Canary Islands, this species has a wide range covering Europe, North America and now the new record from Australia. Twelve specimens before us were bred by Dr E. W. Ferguson from a female captured in Sydney during April, 1922, the flies emerging during September and October of the same year.

Observations—The dates supplied by Dr Ferguson show that the species winters in the pupal stage between twenty-two and twenty-six weeks, whereas all other species so far bred by us have remained only twelve or thirteen weeks.

maximum as a pupa, the one exception being an isolated female that persisted in the pupal condition for a little under twenty weeks

This long wintering period, the fact that the locality Sydney is a port in direct shipping communication with the United States of America, the abundance with which the fly occurs in North America in association with markets and such-like places, as well as the fact that it is the only species yet recorded from



Text-fig 15 *Sarcophaga securifera* Villeneuve
Text-fig 16 *Sarcophaga aurifrons* Macquart
Text-fig 17 *Sarcophaga omega* J & T

Australia with red genital segments, all point to this species as having been introduced into Australia.

SARCOPHAGA AURIFRONS Macquart (Text-fig 16)

Sarcophaga aurifrons, Macquart, Dipt Exot suppl 1, 1846, p. 191—*S. aurifera*, Brauer and Bergenstamm, Denkschr Akad Wiss Wien, lviii, 1891 (*nomen nudum*)—*S. aurifrons*, Brauer, Denkschr Akad Wiss Wien, Math. Nat Cl, cvii, 1898, p. 21, Johnston and Tiegs, Proc Roy Soc Queensland, xxxiii, 1921, p. 71, fig 4, Also xxxiv, 1922, p. 183, Rec. Austr. Mus., xiii, 1922, p. 178—*S. sigma*, Johnston and Tiegs, Proc Roy Soc. Queensland, xxxiii, 1921, p. 84, Rec. Austr. Mus., xiii, 1922, p. 180

Synonymy—The name *Sarcophaga aurifrons* has been applied to quite a number of distinct species by various Australian economic entomologists. In 1921, Johnston and Tiegs determined the identity of a female specimen identified

as Macquart's species by Coquillett. A critical re-examination of the genitalia of *S. sigma* has convinced us that this species belongs to *S. aurifrons* as identified by Johnston and Tiegs and therefore this second name is placed as a synonym. The genital character referred to under *S. sigma* as "laterally there is a curious tube-like structure of a pale brown colour" is a misinterpretation due to chitination giving the appearance of a tube.

Description—♂ Head Outer vertical bristles a little longer than the post-oculars, frontals, nine and eleven respectively on the two sides of the holotype *S. sigma*, seven and eight on the specimen described as *S. aurifrons*; facials three or four, orals eleven, three rows of post-oculars.

Thorax Three intra-alar bristles and a fourth placed presuturally, weak prescutellar acrostichals only.

Abdomen On the first segment, one row of three or four discal lateral bristles and one submarginal. On the second, one lateral submarginal. On the third, one median pair and three lateral submarginals. On the fourth segment, five pairs of submarginals.

Genitalia. Forceps short. Anterior and posterior claspers about equal in length. Anterior process broad and widely expanding, lobe formed into a long process, lateral process very long and slender, apex not, or scarcely, forming a definite process.

Legs The chaetotaxy conforms to the general type. Long hair occurs scantily on the intermediate, and abundantly on the posterior, femora.

♀. The chaetotaxy of the female corresponds rather well with that of the male. There are eight facials on the holotype of *S. sigma* and nine on the specimen described as *S. aurifrons*, which specimen has the facials and orals reduced in number.

Hab—Queensland, New South Wales, South Australia.

Observations—The above description was taken from the holotype and allotype of *S. sigma*, and from male and female specimens described by Johnston and Tiegs as *S. aurifrons*, all these are in the Queensland Museum. The genitalia were drawn from a further specimen marked as being that from which the original drawing was taken to figure *S. aurifrons* and which is also in the Queensland Museum.

SARCOPHAGA OMEGA Johnston and Tiegs (Text-fig 17)

Sarcophaga froggatti, Johnston and Tiegs, Proc. Roy. Soc. Queensland, xxxiii, 1921, p. 73, fig. 12; Also xxxiv, 1922, p. 183; Rec. Austr. Mus., xii., 1922, p. 179, (nec. Taylor)—*S. (Parasarcophaga) omega*, Johnston and Tiegs, Proc. Roy. Soc. Queensland, xxxiii, 1921, p. 86, figs. 25, 26.

Synonymy—As pointed out below under *Sarcophaga froggatti* Taylor, that species conforms to *S. theta* Johnston and Tiegs. *S. froggatti* Johnston and Tiegs was based upon a specimen that had been compared by Mr. G. Hill with the type material in the Tropical Institute, Townsville, but without comparing the male genitalia.

S. froggatti Johnston and Tiegs has its genitalia identical with those of *S. omega*, the excrescences on the head of which are due to a persistence of the ptilinum that is unusually even on each side in this case, but paralleled by similar cases amongst other Muscoidean flies captured by us.

Aldrich determined a specimen of this fly as *S. knob* Parker, but Parker's drawing of the genitalia of that species differs from the one we give here in

several respects and therefore it seems advisable to await further particulars before accepting Aldrich's determination which, if correct, would necessitate reverting to Parker's name

Description.—♂ **Head** Outer verticals apparently absent, nine frontals on one side, ten on the other, three or four minute facials, about twelve orals, one row of post-oculars

Thorax Two intra-alars, presutural and prescutellar acrostichals present

Abdomen On the first segment, two rows of four discal lateral bristles and three submarginals. On the second, two lateral submarginals. On the third, six (or seven) pairs of submarginals, on the fourth segment, six pairs of submarginals alternating with marginals

Genitalia. Forceps short. Claspers simple, anterior much longer than the posterior. Anterior appendix complex, lobe long, directed inwards; lateral process long, apical process and filaments absent

Legs The chaetotaxy differs from the general type by having the second ventral row on the posterior femur reduced to hairs. Long hair occurs on all the femora and on posterior tibiae

Hab—Queensland

Observations—The description is taken from the holotype of *S. omega* in the Queensland Museum. All the specimens grouped under the name *S. froggatti* in the collections examined were captured and not bred, so on this account there are none amongst those revised that can indisputably be placed as the female of this species

SARCOPHAGA ETA Johnston and Tiegs (Text-fig 18)

Sarcophaga eta, Johnston and Tiegs, Proc Roy Soc Queensland, xxxiii, 1921, p. 65, fig. 14; Also xxxiv, 1922, p. 183; Rec Austr Mus, xiii, 1922, p. 178

Description.—♂ **Head** Outer verticals about as long or slightly longer than the post-oculars, eight frontals on one side, nine on the other, two stout facials and a line of further hair-like ones, about twelve orals, two rows of post-oculars

Thorax. Three intra-alars, only prescutellar acrostichals present.

Abdomen On the first segment, two rows of two discal lateral bristles and three submarginal. On the second, two lateral submarginals. On the third, one median pair and three lateral submarginals. On the fourth segment, four pairs of submarginals.

Genitalia. Forceps rather long and slender, seen from the rear they curve outwards. Anterior clasper slightly longer than the posterior. Anterior appendage produced downward into a long process, lobe long and pointed, lateral process long and rather thin; apical process small, unpaired, filaments long.

Legs The chaetotaxy differs from the general type by having the second ventral row on the intermediate and posterior femora reduced to hairs. Long hairs occur on all femora and on posterior tibiae

♀. Four or five orals and only one row of post-oculars. Three intra-alars on one side, two on the other, but on each side there is a further one placed pre-suturally. The second ventral rows on the intermediate and posterior femora are represented by a few bristles

Hab—Queensland

Observations—Our description is taken from the holotype and allotype specimens in the Queensland Museum and it will be noted that the female disagrees with the male in several respects.

In the original description this species is stated to be described from specimens bred from fish, but the allotype bears a label containing "fr bad meat; Brisb 10/20"

Other females examined by us, including some recently bred, have the second row of post-oculars present, and even a third row, indicated on most males, is sometimes definitely indicated on the female, nevertheless, the two rows of discolaterals on the first abdominal segment appear to be a constant feature on the female, whilst the male invariably has but one. In the key we have taken account of our bred specimens in preference to the characters of the allotype, which specimen we consider has been erroneously labelled.

SARCOPHAGA FROGGATTI Taylor (Text-fig 19)

Sarcophaga froggatti, Taylor, Bull. Ent. Res., vii, 1917, p. 265, Parker, Canadian Ent., liv, 1922, p. 8, fig. 4 (Nec Johnston and Tiegs, 1921-2, which = *omega*)—*S. theta*, Johnston and Tiegs, Proc. Roy. Soc. Queensland, xxxiii, 1922, p. 73, fig. 5, Rec. Austr. Mus., xiii, 1922, p. 179.

Synonymy—Since the publication of the description of *S. froggatti* by Johnston and Tiegs, Parker gave another species this name, basing his identification on a single paratype female supplied by Taylor. As it became necessary to ascertain to which species Taylor's name belonged, Mr G. F. Hill, of the Institute of Tropical Medicine, Townsville, kindly submitted the holotype to us for study and to have the genitalia extracted. We find that the paratype examined by Parker has probably been correctly associated with the male, but the details with respect to the anterior appendage, the accessory plate and the three minute spines towards the apex of the forceps are not in accordance with the type. We have drawn the genitalia of Taylor's holotype and this will readily be recognised as being the same as *S. theta* Johnston and Tiegs.

Description—♂ **Head.** Outer verticals a little or scarcely longer than the post-oculars. Nine frontals on one side, eight and ten respectively on the other side of the holotypes of *S. froggatti* and *S. theta*, four very small facials, six orals, one row of post-oculars.

Thorax. Two intra-alar bristles, only presutural acrostichals present.

Abdomen. On the first segment, one row of discal lateral bristles, one strong and one weak submarginal. On the second, one lateral submarginal. On the third, one median pair and two lateral submarginals. On the fourth segment, six pairs of submarginals alternating with slender marginal bristles.

Genitalia. Seen from the rear the forceps are curved inwards. Claspers of about equal length. Anterior appendage with two paired parts, the inner pair being the longer, lobe and lateral process small.

Legs. The chaetotaxy differs from the general type by the absence of the second ventral row on the posterior femur. Long hair on the anterior and posterior femora only.

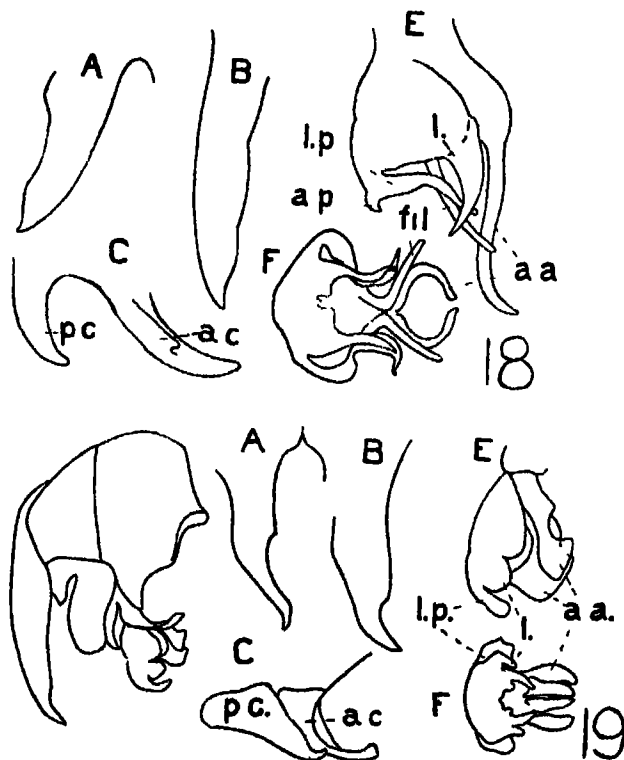
♀ The chaetotaxy of the female corresponds rather well with that of the male, there are eight frontals on the allotype of *S. theta*.

Hab.—Queensland

Observations—The above description was taken from the holotype of *S froggatti* Taylor in the Institute of Tropical Medicine, Townsville, and from the holotype and allotype of *S theta* Johnston and Tiegs, in the Queensland Museum. The original illustration of *S theta* was taken from a paratype specimen.

SARCOPHAGA DEPRESSA (Robineau Desvoidy) (Text-fig 20)

Myophora depressa, Robineau Desvoidy, Essai Myod, 1830, p 353—*Sarcophaga depressa*, Johnston and Tiegs, Rec Austr Mus, xiii, 1922, p 197, Pl xxv, fig 4, Proc Roy Soc Queensland, xxxiv, 1922, p 183—*Myophora musca*,



Text-fig 18 *Sarcophaga eta* J & T

Text-fig 19 *Sarcophaga froggatti* Taylor

- i A drawing of the genitalia taken from the holotype in the Institute of Tropical Medicine, Townsville
- ii Portions of the genitalia taken from the holotype of *S theta* J & T in the Queensland Museum, and to which the letters are attached

Robineau Desvoidy, *ibidem*, 1830, p 360—*Sarcophaga flavifemorata*, Macquart, Dipt Exot suppl 4, 1850, p 233—*S vota*, Johnston and Tiegs, Proc. Roy Soc Queensland, xxxiii, 1921, p 79, fig 11

Synonymy.—The above synonymy is that given by Johnston and Tiegs in 1922

Description—♂ **Head** Outer verticals shorter than the post-oculars, eight frontals terminating parallel with the base of the antennae, five facials, about ten orals, one row of post-oculars

Thorax Three intra-alars and a fourth placed presuturally on one side only, presutural and prescutellar acrostichals present

Abdomen On the first segment, one row of about four discal laterals and one submarginal. On the second, one lateral submarginal. On the third, one median pair and three lateral submarginals. On the fourth segment, five pairs of submarginals alternating with smaller marginals. The whole ventral area of the abdomen is exceptionally hairy

Genitalia Forceps rather long, and seen laterally with a very characteristic heel-like lobe near the apex. A small flange near the apex of the anterior clasper which is a little longer than the posterior. Anterior appendage slender, seen laterally somewhat hidden and scarcely protruding beyond the apex of the enveloping part of the joint; lobe long, directed inwards and therefore mostly concealed; lateral process very broad at the base, but tapering to a slender serrated apex, behind the lateral process a pair of minute processes and behind these again a minute unpaired apical process

Legs At about the middle of the posterior ventral row on the intermediate femur, there are two exceptionally long bristles, in other respects the chaetotaxy conforms to the general type. Long hair on the intermediate and posterior femora.

♀ The chaetotaxy of the female corresponds rather well with that of the male, eight frontals on one side and seven on the other, extending beyond the base of the antennae in the usual manner, only one exceptionally long bristle in the second ventral row of the intermediate femur

Hab—Queensland, New South Wales, Victoria, Tasmania, South Australia, Western Australia

Observations—The above description is taken from the holotype and allotype of *S. tota* Johnston and Tiesg

SARCOPHAGA OMIKRON Johnston and Tiesg (Text-fig 21)

Sarcophaga omikron, Johnston and Tiesg, Proc Roy Soc Queensland, xxxiii, 1921, p. 82, fig. 16, Rec Austr Mus, xiii, 1922, p. 180

Description—♂ **Head** Outer verticals scarcely longer than the post-oculars; ten frontals on one side, eleven on the other, two rows of about four facials each, about six orals, one row of post-oculars

Thorax Two intra-alars, prescutellar and presutural acrostichals present, the latter, however, owing to a fracture, are not to be detected on the holotype

Abdomen. On the first segment, one row of four discal lateral bristles and one submarginal. On the second, one lateral submarginal. On the third, one median pair and two lateral submarginals. On the fourth segment, five submarginals alternating with marginals

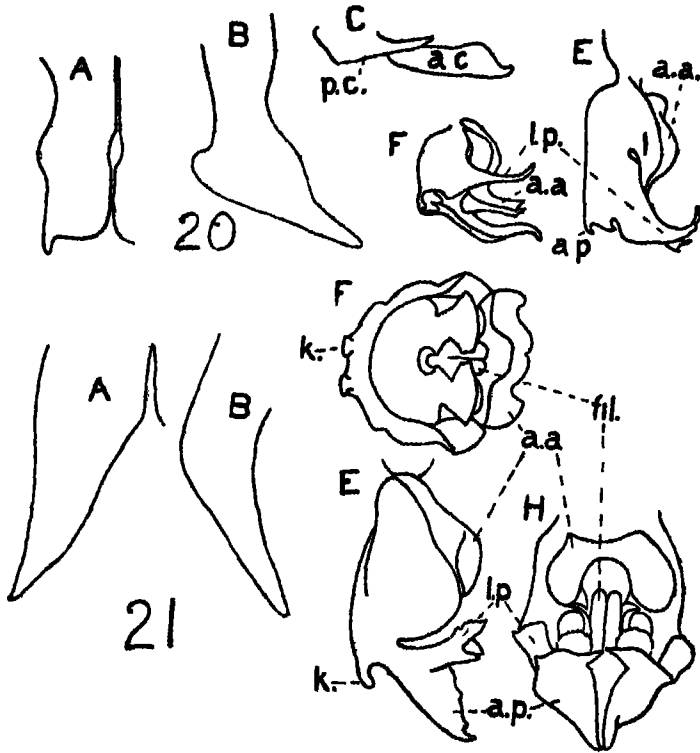
Genitalia Forceps rather simple, curved and diverging towards the apex. Claspers long and strongly curved forward, the anterior one shorter than the posterior. Anterior appendage small; the lobe not at all conspicuous; a pair of knobs is situated at what may be the true apex, but the lateral processes are

complex and joined at the base by a hood that forms a further process, unpaired, filaments presents.

Legs The chaetotaxy differs from the general type by the absence of the second ventral row on the posterior femur. Long hair occurs on the posterior tibiae.

♀. The chaetotaxy of the female corresponds rather well with that of the male. Nine frontals, five submarginals on the third abdominal segment.

Hab—Queensland, South Australia, Western Australia.



Text-fig 20 *Sarcophaga depressa* Desvoidy

Text-fig 21 *Sarcophaga omikron* J & T

Observations.—The description is taken from the holotype and allotype in the Queensland Museum

SARCOPHAGA PEREGRINA (Robineau Desvoidy). (Text-fig. 22)

Myophora peregrina, Robineau Desvoidy, *Essai Myod.*, 1830, p. 356—*Sarcophaga peregrina*, Johnston and Ties, *Rec. Austr. Mus.*, xii, 1922, p. 177, *Proc. Roy. Soc. Queensland*, xxxiv, 1922, p. 182—*Myophora subrotunda*, Robineau Desvoidy, *ibidem*, p. 357—*M. rapida*, Robineau Desvoidy, *ibidem*, p. 360.—*Sarcophaga irregularis*, Walker, *List Dipt. Brit. Mus.*, iv, 1849, p. 830; Johnston

and Tiegs, Proc Roy. Soc Queensland, xxxiii, 1921, p 63, figs 1-3—*S ochripais*, Thomson, Eugenies Kesa, Dipt, 1868, p 537

Synonymy—The above synonymy relating to species described from Australia, is selected from a longer list of synonymy for this species that was published by Johnston and Tiegs, in 1922

Description—♂. Head Outer verticals slightly longer than the post-oculars, eleven frontals on one side, ten on the other, facials, two rows of about five each; about ten orals, three rows of post-oculars

Thorax Two intra-alars, prescutellar acrostichals only

Abdomen On the first segment, two rows of about four discal lateral bristles and one submarginal On the second, one lateral submarginal On the third, one median pair and three lateral submarginals. On the fourth segment, about five pairs of submarginals

Genitalia. Forceps seen laterally constricted at about two-thirds their length, apex broad and terminating in a very short point Claspers slender, the anterior a little longer than the posterior Anterior appendage with a large area of minutely spined structure that is represented in the drawing by a serrated edge, lobe large and broad, with two conspicuous projections, lateral process very broad and containing a small slender projection at the lower corner of the otherwise truncate apex, apical process unpaired and short, arising from just posterior to the base of each lobe is an interior process which is readily detected by the more or less cylindrical shape when seen ventrally, it is not readily perceptible from the lateral aspect, being mostly hidden by other parts of the penis, the nature of this process is not yet understood, and it has only been found in this species and in *S kappa* J & T, in the latter it takes quite a different form

Legs. The chaetotaxy differs from the general type by the absence of the second ventral row on the intermediate and posterior femora, and by the absence of the posterior subapical bristle on the posterior femur Long hair occurs on the anterior and posterior femora

♀ Eleven frontals on one side, nine on the other, three intra-alars and a fourth placed presuturally, two lateral submarginals on the first abdominal segment and those on the second obsolete, the chaetotaxy of the legs conforms to the general type, in other respects the female corresponds with the male

Hab—Queensland, New South Wales, South Australia

Observations—The description is based on a male and a female in the Queensland Museum, which were selected from the series used in 1921, for the account of *S irrequeta* Walker by Johnston and Tiegs, who utilised a general set of characters that occurred in the majority of the specimens and, consequently, their description does not fit any particular pair of specimens in the series The characters of the chaetotaxy are very variable within this species

SARCOPHAGA BANCROFTI Johnston and Tiegs (Text-fig 23)

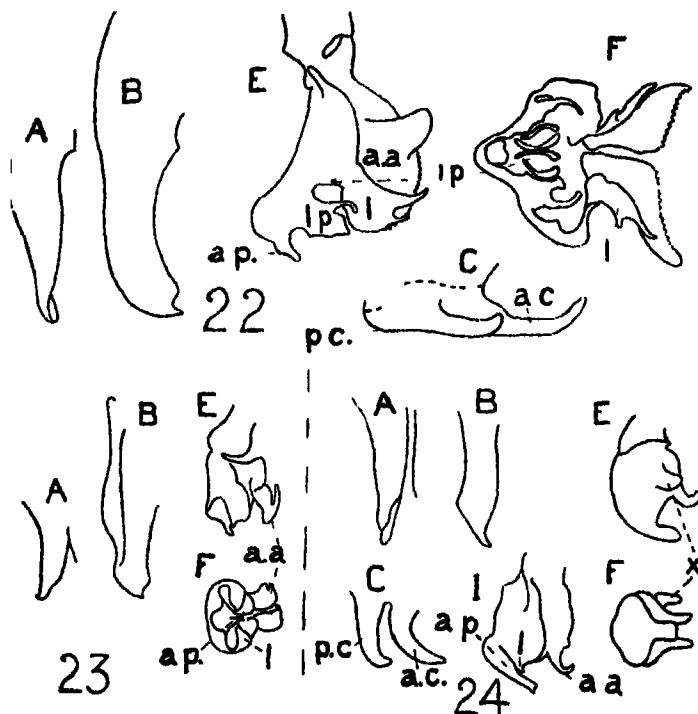
Sarcophaga bancrofti, Johnston and Tiegs, Proc Roy Soc Queensland, xxxiii, 1921, p 85, fig 8

Description—♂ Head Outer verticals obsolete on one side and represented by a very short bristle on the other, nine frontals, one long and three other facials, nine or ten orals, two rows of post-oculars

Thorax Three intra-alars, and a fourth placed presuturally; prescutellar acrostichals present, the presutural acrostichals, if present, are not to be distinguished from the bristly vestiture around them

Abdomen On the first segment, one row of discal lateral bristles and one submarginal. On the second, two lateral submarginals. On the third, five pairs of submarginals. On the fourth segment, six pairs of submarginals.

Genitalia Forceps very short and rather broad. Claspers not sufficiently perceptible to be drawn, but they are simple and of about equal length. Second joint of the penis exceptionally small, anterior appendage folded so that the apex is directed towards the base, lobe present and directed inwards, apical process small and paired.



Text-fig 22 *Sarcophaga peregrina* Deavoidy

The second joint of the penis (E) has the interior process omitted in the lateral view; this process is mostly hidden and arises where indicated by the dotted line from "i p"

Text-fig 23 *Sarcophaga bancrofti* J & T

Text-fig 24 *Sarcophaga ferguson* J & T

The second lateral view (I) of the penis is taken from a specimen that is considered to be *S. ferguson*, and it shows the true shape of the joint which is evidently damaged on the holotype. x indicates an outgrowth occurring on one side only of the holotype and apparently accidental.

Legs. The chaetotaxy conforms to the general type. At most long hair is scantily represented on the posterior femur.

Hab—Queensland

Observations.—The description is taken from the unique holotype in the Queensland Museum.

SARCOPHAGA FERGUSONI Johnston and Tiegs (Text-fig 24)

Sarcophaga fergusoni, Johnston and Tiegs, Proc. Roy. Soc. Queensland, xxxiv, 1922, p 186, fig 2.

Description—♂ **Head** Outer vertical bristles about the length of the post-oculars, ten frontals, about seven facials, ten orals; two rows of post-oculars, the second of which consists of very weak bristles.

Thorax Three intra-alars and a fourth placed presuturally, prescutellar acrostichals only.

Abdomen On the first segment, two rows of discal lateral bristles and two submarginals, but all these are difficult to detect on the holotype. On the second, three lateral submarginals. On the third and fourth segments, six submarginals.

Genitalia Like that of *S. bancrofti*, the penis is very small and we have found it impossible to detect the true nature of the parts on the holotype and therefore the following characters are augmented from a second specimen of this species.

Forceps small and more slender than those of *S. bancrofti*. Claspers simple and of uniform length. Anterior appendage with the apex curved round so as to point towards the base, lobe as in *S. bancrofti*, difficult to detect and directed inwards, apical process larger than in *S. bancrofti* and unpaired.

Legs The chaetotaxy conforms to the general type. Long hairs on all femora and on posterior tibiae.

Hab—New South Wales. The second specimen referred to is from Uralla and is dated 25/11/1914.

Observations—Described from the holotype in the Australian Museum, except the penis which is evidently mutilated on the holotype. In the drawings we have given an outline figure of the penis taken from the holotype, as well as the details taken from a second specimen.

SARCOPHAGA KAPPA Johnston and Tiegs (Text-fig 25)

Sarcophaga kappa, Johnston and Tiegs, Proc. Roy. Soc. Queensland, xxxiii, 1921, p 81, fig 7, Rec. Austr. Mus., xiii, 1922, p 180—*S. illingworthi*, Parker, Canadian Ent., lv, 1922, p 7, figs 3 & 5.

Synonymy—Mr. R. R. Parker informs us that his species, *S. illingworthi*, is the same as *S. kappa*.

Description—♂ **Head** Outer verticals about the length of the post-oculars; nine frontals; four or five small facials, six orals, one row of post-oculars.

Thorax Three intra-alars on one side, two on the other, presutural and prescutellar acrostichals present.

Abdomen On the first segment, one discal lateral and one submarginal. On the second, one lateral submarginal. On the third, one median pair and two lateral submarginals. On the fourth segment, five or six pairs of submarginals.

Genitalia. Forceps rather long and slightly curved. Anterior and posterior claspers short and of about equal length. Anterior appendage small, containing a pair of widely separated and well defined short processes; lobe moderately long, apical process consisting of a pair of broad flanges; two closely adjacent interior processes extend a little beyond the apical processes; they are referred to under the description of *S. peregrina*.

Legs. The chaetotaxy differs from the general type by having only one ventral row on the posterior femur. Long hair on all femora and on posterior tibiae.

♀ Nine frontals on one side, ten on the other, two rows of two discal laterals on the first abdominal segment, the chaetotaxy of the femora conforms to the general type, in other respects the female conforms to the male.

Hab—Queensland, New South Wales

Observations—The description is taken from the holotype and allotype in the Queensland Museum. The one isolated discal bristle on the first abdominal segment is probably due to a reduction of bristles occurring on both sides, where normally the male as well as the female should have two rows of these bristles, similar cases have been found on individual specimens of other species that normally have two rows.

SARCOPHAGA GAMMA Johnston and Tiegs (Text-fig. 26)

Sarcophaga gamma, Johnston and Tiegs, Proc. Roy. Soc. Queensland, xxxiii, 1921, p. 60, fig. 15, Also xxxiv, 1922, p. 182, Rec. Austr. Mus., xiii, 1922, p. 180—*S. brunneopalpis*, Johnston and Tiegs, Proc. Roy. Soc. Queensland, xxxiv, 1922, p. 184, fig. 1.

Synonymy—We have recently secured a series of about forty specimens of this species and have concluded that despite the difference in chaetotaxy, and the supposed difference in genitalia between the two forms, *S. gamma* and *S. brunneopalpis*, the two really represent one species. The differences in the genitalia between the two forms will be found near the apex of the second joint of the penis, where the process-like lobe and the filaments are clearly discernible in one, but hidden and apparently absent in the other. We have observed several specimens that exposed these parts when first the genitalia were extracted, but the penis became distorted on drying and thus came to conform to the "gamma" type. Moreover, there are both forms of genitalia within the series, with and without the corresponding presutural acrostichal bristles.

Mr R. R. Parker informs us that he considers *S. gamma* Johnston and Tiegs, is identical with *S. ochridea* Bottcher, but Bottcher's drawing of the genitalia differs from ours in several respects, the most noticeable of which will be found in the relative size and shape of the claspers. Bottcher's localities include New Guinea, nevertheless we consider it advisable to await further information before accepting this possible synonymy.

Description.—♂ **Head.** The outer verticals about twice the length of the post-oculars, eight frontals, ten on one side in *S. brunneopalpis*; one or two stout facials, about twelve orals, one row of post-oculars.

Thorax. Two intra-alar bristles in *S. gamma*, three in *S. brunneopalpis*, presutural and presentellar acrostichals, the former, however, missing in the holotype of *S. gamma* and in many other specimens of our long series.

Abdomen. On the first segment, two rows of eight discal lateral bristles, five in *brunneopalpis*, and three submarginals. On the second, three lateral submarginals, two in *brunneopalpis*. On the third, one median and three lateral submarginals on *S. brunneopalpis*, but supplemented to form six pairs on *S. gamma*. On the fourth segment, five or six pairs of submarginals that alternate with slenderer marginals.

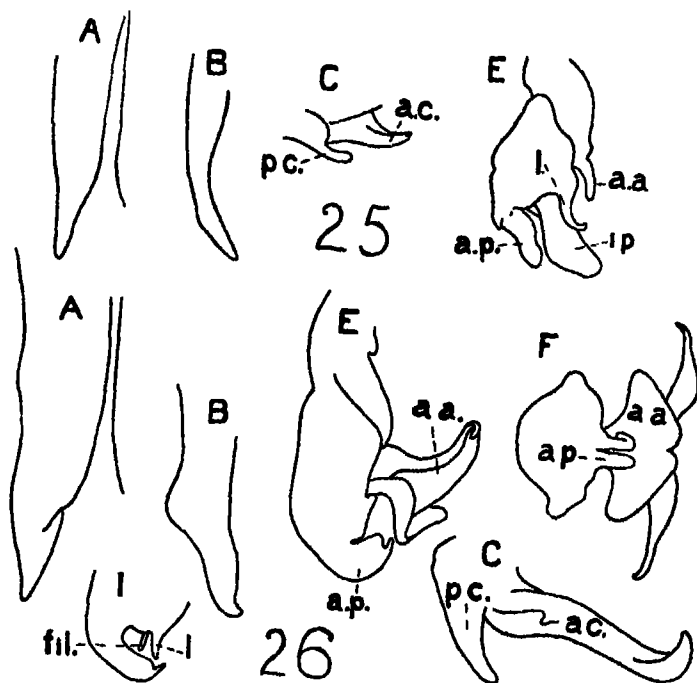
Genitalia. Forceps long. Anterior clasper much longer than the posterior. Anterior appendage widely expanding; lobe forming a small process;

apical process paired, filaments present, the apex of the penis has contracted on the holotype of *S gamma*, so that the lobe and filaments are not apparent on this specimen

Legs The chaetotaxy differs from the general type by having the second ventral row on the posterior femur reduced to hairs. Long hair abundant on the intermediate and posterior femora and on the posterior tibiae

Hab—Queensland, New South Wales

Observations—The description is taken from the holotypes of *S gamma* and *S brunneopalpis* in the Queensland Museum and we have examined about forty further specimens mostly taken around dead birds on Mt. Coot-tha, Bris-



Text-fig 25 *Sarcophaga kappa* J & T

Text-fig 26 *Sarcophaga gamma* J & T

The apex of the penis from the holotype of *S brunneopalpis* J and T (I) shows the true form of the lobe and filaments which characters are concealed in the holotype of *S gamma*

bane, during September, 1922. Although males were very abundant in this locality, we were not able to associate with the species any female specimens also taken during this month.

SARCOPHAGA LITTORALIS Johnston and Tiegs. (Text-fig 27)

Sarcophaga littoralis, Johnston and Tiegs, Rec Austr Mus, xii, 1922, p. 183, Pl xxv, fig 2, Proc Roy Soc Queensland, xxiv, 1922, p 184

Description—♂ Head. Outer verticals not traceable, frontals weak,

twelve or thirteen, scarcely extending beyond the base of the antennae, about four stout facials, four orals, also stout, one row of post-oculars

Thorax Badly denuded, probably there are three intra-alars and both presutural and prescutellar acrostichals present

Abdomen On the first segment, one row of about three discal laterals and one submarginal. On the second, one lateral submarginal. On the third, one median pair and two lateral submarginals. On the fourth segment, seven pairs of submarginals alternating with marginals

Genitalia Forceps broad, terminating in a pointed apex. Claspers simple and small, the anterior longer than the posterior. Anterior appendage small, lobe plainly discernible, the apex consists of a pair of broad flanges, the lower edge of each containing a small fold, the flanges are arranged hood-like, so that the interior of the penis cannot be seen from the ventral aspect

Legs The chaetotaxy differs from the general type by the absence of the subapical bristles on the posterior femur. Long hair occurs scantily on all femora. ♀ Frontals eleven or twelve. As in the male, the thorax is damaged, but there are probably three intra-alars, and a fourth placed presuturally, both presutural and prescutellar bristles may be present. The intermediate legs are missing, the posterior femur contains one anterior row of bristles, one subapical dorsal bristle and at least one ventral row

Hab—Queensland.

Observations—The above description is taken from the holotype and allotype in the Australian Museum, both specimens are in a very dilapidated condition.

SARCOPHAGA SYNIA, n sp (Text-fig 28)

Description—♂. **Head** The outer vertical bristles scarcely longer than the post-oculars, ten frontals on one side, eleven on the other, two strong and four or five weak facials, ten orals, three rows of post-oculars, but the two posterior ones are formed of rather slender bristles. Third joint of antennae slightly longer than twice the length of the second. Frontal stripe as wide as parafrontals

Thorax Three intra-alars and a fourth placed presuturally, presutural and prescutellar acrostichals present

Abdomen On the first segment, a row of four discal lateral bristles and one submarginal. On the second, one lateral submarginal. On the third, one median pair and three lateral submarginals. On the fourth segment, five pairs of submarginals

Genitalia Forceps rather simple but terminating in a double point. Anterior claspers with a small flange near the apex, the posterior smaller and simple. The second joint of the penis recalls that of *S. carnaria* Meigen, the anterior appendage consists of a pair of bowed processes that almost meet at the apex, the lobe is very well differentiated, the apex curves forward like that of *S. carnaria* and is unpaired. filaments present.

Legs The chaetotaxy differs from the general type by the number of bristles in the ventral rows on the intermediate femur being reduced, and by the anterior and the second ventral row on the posterior femur being obsolete

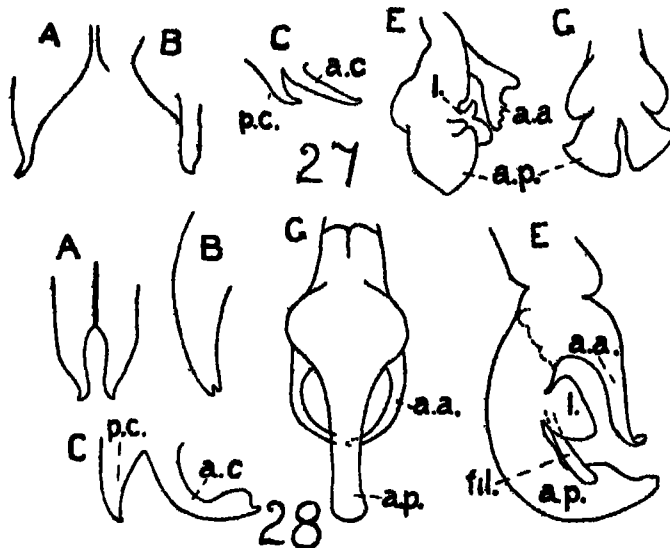
Colour—Silvery grey, with slight indications of yellowish in places

Length—12 mm.

Hab.—Queensland. Mt Coot-tha, Brisbane, September, 1922, one male, unique.

Observations—This species bears a remarkable resemblance to *S. carnaria* Meigen in regard to the characters of the male genitalia, in both species the forceps and claspers are of about the same length and of the same general form; the penis also agrees in having characters in common. Possibly this species is the original one upon which the record of *S. carnaria* in Australia was based.

The specimens of *S. carnaria* Meigen examined by us consist of two males and a female from Europe, a male determined by C. J. Wainwright in 1915, and a pair determined by Bottecher and kindly supplied by Dr. M. Bezzi.



Text-fig 27 *Sarcophaga littoralis* J & T
Text-fig 28 *Sarcophaga symia*, n. sp.

UNRECOGNISED SPECIES

Sarcophaga praedatrix Walker (List Dipt Brit Mus, iv, 1849, p. 826).

Status—This species was described by Walker as having the third antennal joint three times the length of the second, and the length of the body five lines. The remainder of the account would fit almost any species of the genus. It was evidently described from a moderately large specimen, not particularly "golden," in which the third antennal joint is longer than usual and such characters would conform to the female of *S. kappa* Johnston and Tiegs.

Locality—Port Essington, Northern Territory.

Sarcophaga pallidus Thomson (Eugenies Resa, 1869, p. 539).

Status—This species has been placed provisionally by Van de Wulp under *Sarcophagula*. Its small size suggests *Helicobia australis*, but the original description seems to indicate that it is not a Sarcophagid fly.

List of works referred to

- ALDRICH, 1916—*Sarcophaga* and allies in North America.
- BOTTOHER, 1912-13—Die mannlichen Begattungswerkzeuge bei dem Genus *Sarcophaga* Meigen, und ihre Bedeutung für die Abgrenzung der Arten *Deut Ent Zeit*, Berlin
- , 1913—Sauters Formosa-Ausbeute Einige neue *Sarcophaga*-Arten *Ann Mus Nat Hungarici*, xi, pp 374-381
- BRAUER, 1898—Beiträge zur Kenntniss der *Muscaria schizometopa*. *Sitz k Akad Wiss, math-nat Cl Abth*, (vii)
- GRAHAM-SMITH, 1914—Flies and Disease, non-bloodsucking flies Second edition, p 35 (recording *Sarcophaga carnaria* L. from Australia)
- GUERIN, 1830—Voyage de la Coquille, zoologie ii
- JOHNSTON and HARDY, 1923—Some *Sarcophagid* flies from Lord Howe Island *Rec Aust Mus*, xiv (1), 62-71
- JOHNSTON and TIGGS, 1921—New and little known *Sarcophagid* flies from South East Queensland *Proc Roy Soc Queensland*, xxxiii, pp 46-90
- , 1922—*Sarcophagid* flies in the Australian Museum Collection *Rec Aust Mus*, xii, pp. 175-188
- , 1922—New and known Australian *Sarcophagid* flies *Proc Roy Soc Queensland*, xxxiv, pp 181-190
- MACQUART, 1846, 1850—*Diptères exotiques nouveau ou peu connus*, supplements 1 et 4 Reprinted from *Mém Soc roy Sci, Agric et Arts*, Lille, 1838-54
- PARKER, 1922—Australian *Sarcophagidae*, new species and data concerning others *Canad Entom*, liv, pp 4-9
- ROBINEAU DESVOIDY, 1830—Essai sur les Myodaires *Mem Acad Sav étrangers*, ii, Paris
- TAYLOR, 1917—*Sarcophaga froggatti*, a new sheep-maggot fly *Bull Ent Res* London, vii, p 265
- THOMSON, 1868—Sweden *Kongl Sv Freggatten Eugenes Resa*, etc, ii, zool, part 12, Dipt
- TOWNSEND, 1917—Genera of the Dipterous tribe *Sarcophagini* *Proc Biol Soc*, Washington, xxx, pp 189-197
- VILLENEUVE, 1908—In Becker. *Dipteren der Kanarischen Inseln* *Mitt Zool Mus*, Berlin, iv, pp 121-126
- WALKER, 1849—Last of the Dipterous insects in the British Museum, iv

THE LORANTHACEAE OF AUSTRALIA Part IV

By W. F. BLAKELY, Botanical Assistant, National Herbarium, Sydney

(Plates III-XIV)

[Read 18th April, 1923]

9. *LORANTHUS QUEENSLANDICUS*, n. sp. (Plate III)

Frutex ramis glabris robustis teretibus vel apud nodos minime compressis. Folia opposita late-spathulata ad elliptica plana glabra superne nitentia subcoriacea 3-5 costata in semi-tereti petiolo attenuata 4-7 cm x 3-4 cm. Inflorescentia cymosa cymis axillaribus corymbosis communium pedunculo crasso 3-5 cm longo 3-6 radiato utroque radio cymum 3 florum flavorum quorum centralis sessilis terente. Geminae cylindræ 30-35 mm facilius in 6 libera linearia segmenta separatae. Antheræ adnatae lineares 4 mm. Stylus gracilis subangularis 37 mm. Stigma minorum. Fructus urceolatus vel ellipticus glaber 8-12 mm.

Branches glabrous, robust, terete, or slightly compressed at the nodes. Leaves opposite, broad spatulate, elliptical, flat, smooth and shining above, dull beneath, 4-7 cm long, 3-4 cm broad, thin, coriaceous, 3-5-nerved, the numerous fine lateral nerves indistinct, narrowed into a semiterete petiole 6-10 mm long. Flowers yellowish-brown, in axillary sub-corymbose cymes, the common peduncle rather thick, 3-5 cm long, bearing 3-6 rays, each with a partial cyme of 3 flowers arranged in triads, the central flower sessile, the lateral flowers on stout, bracteate pedicels. Bracts of the sessile flowers rather large, concave, lanceolate, gibbous, bracts of the lateral flowers smaller, broad spatulate to elliptical, or nearly orbicular, truncate, minutely rusty tomentose inside and on the margins, much enlarged under the fruit. Calyx broad cupular, the limb somewhat prominent, slightly contracted, truncate or minutely ciliate-denticulate. Buds cylindrical, 30-35 mm long, readily separating into 6, free, narrow linear segments when mature, petals acute, bearded inside at the apex with a tuft of minute brown deciduous hairs.

Filaments very narrow, 9 mm long, anthers adnate, linear, 4 mm long. Style 37 mm long, slender, sub-angular, stigma very small. Disc flat. Fruit urceolate to elliptical, smooth, 8-12 mm long, but not seen ripe. Epicarp thick.

Range—This species is at present confined to the north-east coast of Queensland.

Barron River, native name "Darandool" (E. Cowley, No. 56 in Queensland Herbarium). Recorded as *L. dactyophlebicus* in Bailey's "Comprehensive Catalogue of Queensland Plants," p. 460, Herberton (S. Dixon. The type), Cairns (F. M. Bailey, in Queensland Herbarium).

Affinities—*L. Queenslandicus* is very closely allied to *L. barbellatus* Blakely, a New Guinea species, from which it differs in the less coarse and more obscurely veined leaves; larger peduncles and pedicels, more variable bracts, longer and thicker buds, and in the filaments being twice the length of the anthers, also in the depressed disc, and rusty vestiture of the calyces and bracts.

It shows affinity with *L. congener*, especially the short broad elliptical forms of the latter, but it is much larger than *L. congener* in all its parts.

Host not stated.

10 *LORANTHUS CYONEUS-SINUS*, n. sp. (Plate IV. fig. A)

Frutex glaber ramis brevibus robustis divaricatis, lenticulatis, quorum nodi laeves paulis per prominentes. Folia opposita, crassa, coriacea, elliptica ad orbicularia petiolata obscure 3-5 costata, 3-5 cm longa, 20-25 mm lata. Cymae axillares, deflexae, bis vel ter ramati, utroque ramo portantes tres flores, quorum centralis sessilis. Gemmae graculis clavatae unctae 15-20 mm longae. Bractae obtusae aequantes dimidium calycem. Calyx urecolatus, lamina ciliatis membranaceis, segmentis 5, liberis. Antherae oblongo-ellipticae filamentis tenuibus adnatae. Stylus angularis, stigma magnum, capitatum. Fructus non visi.

Glabrous, branches divaricate, firm, lenticulate, with somewhat prominent smooth nodes. Leaves opposite, thick, coriaceous, broadly elliptical to almost orbicular, petiolate, obscurely 3-5-nerved, 3-5 cm long, 20-25 mm broad. Inflorescence cymose. Cymes deflexed, 2-3-branched or more, the common peduncle slender, 5-8 mm long. Flowers in triads, the central one sessile. Buds slender, clavate, greasy, 15 mm long. Bracts obtuse, about half the length of the calyx. Calyx urecolate, 2 mm. long, the membranous limb ciliate, entire or minutely toothed. Segments 5, free to the base. Anthers oblong elliptical, adnate to the rather thin filaments. Style angular in the lower half, thicker than the filaments; stigma large, capitate, minutely verrucose. Fruit not seen.

Range—Cygnet Bay, West Kimberley (W. V. Fitzgerald, labelled *L. pendulus* Sieber).

Affinities—This species is more closely allied to *L. miraculosus* Miq., than to any other, it is separated by the more coriaceous tri- or quinque-nerved leaves, thicker buds, differently shaped calyx and larger stigma.

In foliage it resembles the elliptical forms of *L. congener* Sieber, but varies in other characters.

Host not stated.

11 *LORANTHUS MACKAYENSIS*, n. sp. (Plate IV. fig. B)

Folia opposita juniora in superfine ventrali ferruginea haud tamen tomentosa, elliptica ad obovata, flaccida, opaca, in petiolo obvio constricta, obscure triplinervata, 2-4 cm longa, 15-20 mm lata. Flores in cymis axillaribus, pedunculo communis deflexo perente umbellum trirem radiorum, quorum utroque tribus floribus, centrali sessili. Gemmae acuta clavatae tenues 10-17 mm longae. Bractae acutae, minute ciliatae, calycem non supereminentes. Calyx cylindricus, vestice constricto deum in gemma, repandus segmentis cadentibus, lamina brevissimis minute ciliatis 2-5 mm longis, segmentis 5, omnino liberis, antherae oblongae adnatae, 2 mm longae. Stylus tenuis angularis, stigma parvum. Fructus non visi.

Glabrous shrubs with short divaricate branches. Leaves opposite, the young leaves ferruginous underneath but not tomentose, elliptical to obovate, thin opaque, rounded or contracted at the base into a distinct petiole 3-4 mm long, obscurely

tripinnate, 2-4 cm long, 15-20 mm broad. Flowers in axillary cymes, the common peduncle deflexed, about 10 mm long, bearing an umbel of 2 or 3 rays, each with 3 flowers, the central flower sessile. Buds very slender, clavate, acute, 10-17 mm long. Bracts acute, minutely ciliate, not exceeding the calyx. Calyx cylindrical, contracted at the top in bud, expanded when the petals fall, the limb very short, minutely ciliate, about $2\frac{1}{2}$ mm long. Petals 5, free for their entire length. Anthers oblong, about 2 mm long. Style slender, angular, stigma very small. Fruit not seen.

The material is imperfect and does not allow a full description.

Range—Mackay, North Queensland (H. Tryon).

Affinities—Allied to *L. mirabilis* in general appearance but diverging in the more elliptical, non-glaucous leaves, slender buds and cylindrical calyxes.

L. cynensis-Sinus resembles this species in the shape of the leaves, which are, however, thicker, and usually quinque-nerved, while the buds are thicker, more clavate, and the stigma considerably larger. The calyx, also, is more urceolate with a correspondingly larger limb.

L. Mackayensis also bears some resemblance to *L. obliqua*, notably in the common peduncle, bracts, and to some extent in the buds.

Host not stated.

12. LORANTHUS MIRABILIS Miq. (Plate v)

Lehm., *Plantae Preiss.*, 1844, p. 281.

The following is a translation of the original description.—Branches glabrous, terete, internodes usually compressed. Leaves opposite, shortly petiolate, fleshy or leathery, elliptical or subspathulate-lanceolate, contracted at the base, the apex obtuse, veinless or obscurely one-nerved. Cymes shortly pedunculate, two or three branched, each branch bearing three flowers, the central one sessile. Bracts rounded-ovate or navicular, the apex ciliate. Calyx truncate.

Parasitic on *Santalum* sp., near Wicklow, 8th March, 1841 (Herb.) Preuss., No. 1607, in flower, near York, 12th April, 1840, No. 1610, without flowers.

A large species similar to the host plant, showing remarkable manner of parasitism and natural physiology worthy of note. Not only are the leaves the same shape, structure and venation, but the young branches are flattened, the old ones terete, and of a similar nature to the shrubs of *Santalum* on which it grows, but a little yellower, glabrous, dichotomously branched, branches smooth, branchlets usually dilated or compressed at the top. Leaves opposite or slightly alternate, leaving a scar as they fall off, thick, carnosous, coriaceous, elliptical or spathulate-lanceolate, obtuse or rounded at the top, contracted into a cuneate base $2\frac{1}{2}$ - $4\frac{1}{2}$ cm long, $1\frac{1}{2}$ cm broad, nerveless or obscurely 1-nerved, petiole channelled above, 3-4 mm long. Cymes corymbose, axillary and terminal, shorter than the leaves, two- or three-branched, frail, peduncles triflorous, flowers pedicellate, or the central one sessile. Bracts fleshy, rounded-ovate or boat-shaped, concave, the apex minutely ciliate. Calyx obconic, repand-truncate, 2 mm long, or smaller. Petals 5, brown when dry, linear spathulate, the apex elliptical, concave, 8-9 mm long. Stamens small, inserted towards the middle of the petal, anthers linear-elliptical. Style filiform, slightly exceeding the stamens, angular or sulcate, flexuose in the upper portion, stigma verrucose, sub-capitate.

Supplementary notes to the description

Glabrous and somewhat glaucous plants with erect or pendulous branches 1-2

feet long, often forming dense masses up to 3 feet in diameter Union ball-like, often larger than in most species, exceeding 6 inches in diameter Bark on the old stem dark and rough, similar to that of *Exocarpus cupressiformis*

Leaves opposite, thick, very variable, elliptical, spathulate, cuneate and lanceolate sometimes on the same branch, 2-6 cm long, 1-2 cm broad, in the typical form, venation imperfectly triplinerved or somewhat penninerved, approaching that of *L. vitellinus*, occasionally three nerves more conspicuous than the others, but frequently the central nerve alone conspicuous, petioles 5-10 mm long, terete or compressed Cymes axillary or terminal, 2-4-branched, usually shorter than the leaves, the common peduncle 10-15 mm long Buds robust, usually crimson, or Old Carmine, clavate, or angular at the top and slightly swollen at the base, quite glabrous, only the small ovate bract minutely rufous ciliate Calyx obconical to cylindrical, the conspicuous broad membranous limb irregularly denticulate-ciliate Flowers 4-5-merous, 15-20 mm long Petals free, dark red at the base shading into orange-red upwards, the apex acute Style slender, geniculate, on a level with the base of the anthers, of a dark-red colour throughout, and pentagonal or deeply furrowed for its size Stigma rather large, somewhat capitate Anthers oblong, 3-4 mm. long Fruit oblong, 8 mm long, about 4 mm in diameter, contracted at the top, usually a light yellow Seeds elliptical, 5 mm long, with 5 scarcely perceptible furrows Endosperm green, hypocotyl terete, minutely verrucose, green Embryonic cotyledons oblong-obtuse, scarcely 3 mm long On germination the disc and hypocotyl become a deep purple-brown in colour Cotyledons not withdrawn from the endosperm on germination

L. miraculosus Miq was described from specimens collected at Wicklow and York, by Preuss in 1840-41

I have not seen the type, but have been informed by Professor Le Comte that only fragments of it remain in the Paris Herbarium I have also been advised by Professor Carl Lindman that it is not represented at Stockholm, and that "they do not possess by far all the species of Preuss' collection"

I have examined specimens from practically the type locality which answer in nearly every detail to the original description

The leaves figured by Fittingshausen (Über die Blattskelette der Loranthaceen, tab. II, Fig. 27, 29) match specimens from Dongarra, Mogumba, Cunderdin and other localities in Western Australia.

Bentham (Flora Australiensis, III, 394) unites *L. miraculosus* Miq, and *L. Melaleucæ* Lehm, and reduces them to a variety of *L. pendulus* Sieber, var *parviflorus* Benth

It appears to me that he also includes *L. Gaudichaudi* DC by including Woolls's Parramatta specimens under his var *parviflorus* His description of var *parviflorus* is rather vague and would apply to either *L. Gaudichaudi* or *L. Melaleucæ* "Leaves small and narrow, flowers small, often 4-merous, the central ones sessile"

I have only seen one specimen referred to by Bentham under var *parviflorus*, that of C. Wilhelm, from Port Lincoln, which undoubtedly answers to the description of *L. Melaleucæ*

Other localities quoted by Bentham are New England, Barrier Range, interior of South Australia, and Swan River These in my opinion, are referable to *L. miraculosus* Miq, and Rottneet Island to *L. Melaleucæ* Lehm The latter appears to be a narrow-leaved form of the former

Professor Ewart, commenting upon this species (Proc Roy Soc Vict, NS,

xxx1, 1918 (1919), 374), remarks, "Although the differences from *L. pendulus* are not very great (smaller leaves and flowers and the latter often 4-partite, etc.), the plant seems to form a constant and well marked type, with a facies distinct from *L. pendulus*."

He then proceeds to discuss the position of *L. miraculosus* in conjunction with *L. Melaleucæ* Miquel (Plantae Preussianae, 1, 281) quotes a species, No 6, under a manuscript name of Lehmann's, as *L. Melaleucæ*, which is the same as the following species, No 7, *L. miraculosus*, and strict priority rule requires that the earliest name should stand.

Lehmann, as editor of the work, presumably consented to the publication of the manuscript name, but as the whole article on Loranthaceae is by Miquel, it would seem to be more appropriate to retain his name for the species, namely *L. miraculosus* Miquel.

Synonym - *L. pendulus* Sieb var *parviflorus* Benth

Range - This is a variable species, particularly in the leaves and flowers and also to a lesser extent in the cymes. The typical form extends from Western Australia to New South Wales, as will be seen by the following localities - Western Australia Murchison River (on *Eucalyptus gomphocephala* and *Fusanus acuminatus*) Greenough Dist (J Drummond, Hook Journ Bot, 5, 1853, 143), Geraldton, Dongarra (on *Acacia costellifera*), Hills in the vicinity of Irwin and Dongarra (Diels and Pritzel, Bot Jahr, 35, 1906, 176), Mogumber (on *Fusanus acuminatus*), Swan River (quoted by Benthams), York (The type locality, on *Eucalyptus gomphocephala*), Cunderdin (on *Fusanus acuminatus*), Bruce Rock, Meriden District (closely approaching the variety *Boormanii*), near Mt. Malcolm ("Parasitic on the Quandang, *Fusanus pericaryus* and homoplastic with it" S L Moore, Journ Bot, xxv, 1897, 169) South Australia Ooldea (recorded as *L. pendulus* in Trans Roy Soc SA, vi, 1917, 379) The flowers are highly coloured and resemble the flowers of *L. Miquelii* in a dry state and were it not for the central one being sessile, and the short leaves, the specimen would pass for that species. Mr Black in the same Journal, xlii, 1919, 29, records it under *L. miraculosus* "Leaves 1-6 cm long, thick, nerveless, oblanceolate, the central flower of each partial cyme is sessile, corolla 15-20 mm long" Interior of South Australia (quoted by Benthams under *L. pendulus* var *parviflorus*), Robe, Yorke Peninsula (on *Melaleuca parviflora* (recorded in Trans Roy Soc SA, xlii, 1918, 29), East Plains (The specimen is not typical, but is inclined towards the variety *Boormanii* in the shape and length of the leaves) There is a specimen in the National Herbarium, Sydney, from South Australia (W Gull), without definite locality, which is nearly typical *L. miraculosus* Victoria Dumosa (on *Loranthus knopphyllus*, the latter on *Casuarina Luehmannii*), Wycheproof, River Murray, on *Santalum lanceolatus* (Ned Kruidk Arch, iv, 1856, 105), Genoa River, on *Angophora intermedia* (Vict. Nat, xxvi, 1920, 152)

New South Wales Mt Bolton, near Moruya (on *Casuarina stricta*), South West Plains below Narrandera, (on *Loranthus Miquelii*, the latter on *Eucalyptus hemiphysa*, var *microcarpa*), Albury Road, near Wagga Wagga, (on *L. Miquelii* Lehm, the latter on *Eucalyptus dealbata* (*L. miraculosus* was in flower and *L. Miquelii* in fruit), Barrier Ranges (quoted by Benthams under *L. pendulus* Sieb var *parviflorus*), Zara, Wanganella (on *Fusanus acuminatus*, *Eremophila longifolia*, *Acacia pendula*, and *Myoporum acuminatum*), Temora (on *Fusanus acuminatus*), Barmedman (on *Fusanus acuminatus*), Parkes (on *Geijera parviflora*), Harvey Ranges (showing example of double parasitism on *L. Miquelii*, the latter

on *Eucalyptus comeca*), Wellington (on *Santalum* and, in three instances, on *L. pendulus*, the latter in those three instances growing on *Eucalyptus hemiphloia*), Dubbo (on *Pittosporum phylliracoides*). Another specimen showed self parasitism), Cobar District ("Small pretty flower, on the Wilga trees as a rule, flowers in June," These Proceedings, xxxvi, 1911, 523). Moonbi, New England, Narrabri (on *Eremophila Mitchelli*), Pilliga East State Forest, Co Baradine, 15 miles E of Wangan (on *Fusanus acuminatus*)

Affinities—This species appears to have much in common with *L. congener* Sieb in general appearance, and in morphological characters, it is, however, more glaucous and glabrous, and the leaves are more variable, with a relatively different venation, the cymes and flowers are also more glabrous, and the fruits are yellow, not green when ripe.

Its affinity with *L. Gaudichaudi* DC lies chiefly in the similarity of the leaves with those of the variety *Melaleucæ*. It is, however, sharply separated in the shape of the fruits, which are oblong or elliptical, while those of *L. Gaudichaudi* are globose and bright red, or deep pink in colour.

J Drummond (Hooker's Journ Bot, v, 1853, 143) refers to "*L. mirabilis* from Greenough District," and compares it with "*L. Quandang* Lindl, in foliage of which there is a close resemblance in shape and size, but the former is always glabrous, and the latter pubescent." Drummond's observations are both interesting and correct.

Fodder Value—Spencer Le M Moore, writing on the Camel food of Western Australia (Ion Journ Bot, xxxv, 1897, 169) records this species under *L. pendulus* var *parviflorus* Rth as an excellent fodder plant.

Mr W Bauerlen writing from Wellington, N S W, 11 2 1903, states that cattle eat the drooping shoots as high up as they can reach, while they leave the host plant, *L. pendulus*, alone even when far easier to reach. He also observed the cattle eating it and the var *Boormanii*, at Mt Hope, near Cobar, in 1904.

Hosts—*Casuarinaceæ* *Casuarina Luehmannii* Baker *Loranthaceæ* *Loranthus inophyllus* Fenzl, *L. Miquelii* Lehm, *L. pendulus* Sieber *Santalaceæ* *Fusanus acuminatus* R Br, *F. persicarius* F v M., *Santalum lanceolatus* R Br *Pittosporaceæ* *Pittosporum phylliracoides* DC *Rutaceæ* *Geijera parviflora* Lindl *Leguminosæ* *Acacia rostellifera* Benth, *A. pendula* Cunn *Myrtaceæ* *Eucalyptus Bauermanii* Schau, *E. comeca* Deane & Maiden, *E. gomphocephala* DC., *Angophora intermedia* DC., *Melaleuca parviflora* Lindl *Myoporaceæ* *Eremophila longifolia* R Br, *E. Mitchellii*, *Myoporum acuminatum* R Br.

(a) Var *MELALEUCÆ* (Tate), n comb (Plate vi)

Tate, Trans Roy. Soc. S A, iii, 1879-80, 66 (as *L. pendulus* Sieb. var *Melaleucæ*, Lehm, Plant Preiss, i, 1844-45, 281, Walp. Rept Syst, v, 1845-46, 938, Miq, Ned. Kruidk Arch, iv, 1856, 105, Benth, B Fl, iii, 1866, Ettings, Über die Blatts, der Lor., 1871, p 11, Tab 11, Figs 13, 14.

The following is a translation of the original description—Glabrous, branches and branchlets terete; leaves opposite or subopposite, tapering into a somewhat long petiole, coriaceous, narrow spatulate, blunt, gradually contracted into the petiole, veinless or obscurely one-nerved, or usually somewhat veiny or reticulate above. Flowers corymbose, pedicellate, 4-merous, supported at the base by a glabrous, oblong, concave bract. Calyx conical or cylindrical, the limb somewhat long, spreading truncate. On the branches of *Melaleuca*, Rottneist Island,

18th August, 1839, (Herb) Preiss No 1616 A small shrub with numerous forked branches, the old branches cylindrical, covered with a smooth dark grey bark, leaf scars tuberculate, branchlets subterete. Leaves 2-4 cm long, 6-8 mm broad at the top, easily detached, petioles semiterete, confluent with the lamina, $\frac{1}{2}$ to nearly 1 cm long. Pedicels rounded, thickened upwards, 6 mm long. Calyx tube 7 mm long, carinose, the limb very long, dilated, somewhat undulate, truncate, scarcely repand.

The following is a translation of Fittingshausen's description of the leaves — Leaves oblong, wedge-shaped, petiolate, apex obtuse, venation uniting, primary nerve distinct, branching below the apex, secondary nerves 1-3, thin on both sides above the base, directed towards the margin, tertiary nerves small, scarcely conspicuous.

The type is in the Paris Herbarium, but like *L. miraculosus*, it is but a mere fragment.

Mueller (Ned. Kruidk. Arch., iv, 1856, 105) expressed the opinion that it was the same as *L. miraculosus* Miq., I think however it is sufficiently distinct to warrant a varietal name until we know more about it.

There is a specimen in the National Herbarium, Sydney, collected by C. Wilhelm at Port Adelaide, South Australia. It does not differ in any way from Wilhelm's Port Lincoln specimen.

Professor R. Tate (Trans. Roy. Soc. S.A., iii, 1879-80, 68) recorded it as *L. pendulus* Sieb. var. *Melaleuca* without a description. His specimen which was kindly lent by Professor Osborn of the University of Adelaide Herbarium is somewhat larger than Wilhelm's specimen, being intermediate between the typical *L. miraculosus* and var. *Boormanii*.

This variety is a smaller and more compact shrub than the typical *L. miraculosus*, with usually narrow cuneate or narrow spatulate leaves, the narrow 1-nerved, and the larger or broader ones 1-3-nerved. Buds variable, sometimes quite normal, but in some specimens they are longer and more robust and pass imperceptibly into var. *Boormanii*. While it keeps to the coast, the leaves are fairly uniform, but, as it extends its range to the drier interior, they become gradually larger until the variation is excessive, hence the description of a new variety, var. *Boormanii*. Nevertheless, careful field observations are necessary to determine the exact relationship between it and *L. miraculosus* Miq.

It is singular that it is invariably parasitic on the genus *Melaleuca*.

Synonyms — *L. Melaleuca* Lehm., *L. pendulus* Sieb. var. *parviflorus* Benth., *L. pendulus* Sieb. var. *Melaleuca* Tate.

Range — *Western Australia* Rottnest Island (A. Cunningham, Preiss, No 1616) and probably Swan River (quoted by Benth.). *South Australia* Bunda Plateau (on *Fusanus*). Recorded by Professor Tate in Trans. Roy. Soc. S.A., ii, 122 (1878-9), as "*L. pendulus* Sieb. var. *Melaleuca* Lehm." Specimen already referred to Fowlers Bay (on "tea-tree"), Murat and Denial Bays (on *Melaleuca cymbifolia* Benth. (recorded by J. H. Maiden, Trans. Roy. Soc. S.A., xxxii, 1908, 263), Unley Scrub (in Herbarium, University of Adelaide), Compass, No 1025, on "tea-tree," probably collected by Professor Tate (in Adelaide Herbarium), Port Lincoln (in Herb., Melbourne), Androssa (on *Melaleuca ericifolia* in Adelaide Herbarium), also recorded by O. Tepper, Trans. Roy. Soc. S.A., iii, 1879-80, 39. *South York Peninsula* (in Adelaide Herbarium), Port Vincent, York Peninsula (flowers scarlet petals free, 13-14 mm long; flowers corymbose, 3 rays, bearing 3 flowers each, leaves opposite, cylindrical, but slightly

verticillate, comparatively obtuse, sulcate, on *Melaleuca Preussiana*. This is the narrowest leaved specimen I have seen of this variety), White Lagoon, Kangaroo Island (on *Melaleuca* sp., vide J. H. Maiden, Proc. Linn Soc. N.S.W., **xxix**, 1904, 696), near Port Adelaide, Murray River (Ned Kruidk. Arch. iv, 1856, 106).

Affinity—This variety bears a striking resemblance to *L. Gaudichaudii* DC in the leaves, when they are one-nerved, but it will be observed that the young shoot and leaves are strictly glabrous, whereas the leaves of *L. Gaudichaudii* are minutely tomentose in the early stages.

The buds of var *Melaleucæ* are larger and more striate and of a yellowish colour.

The fruits of both, when available, afford a ready means of discrimination between them, they are yellowish, and slightly urceolate or elliptical in var *Melaleucæ*, and bright pink, or light red, and constantly spherical in *L. Gaudichaudii*.

Hosts—Santalaceæ *Fusanus* sp. Myrtaceæ *Melaleuca cymbifolia* Bth, *M. ericifolia* Sm, *M. Preussiana* Schau.

(b) Var *BOORMANI*, n. var. (Plate vii)

Frutex glaber plerumque pendulus ramis tenuibus nonnumquam ultra 3 pedes saepe caespitem densum generans fusiformis. Folia angusta late linearia vel linear-oblonga 2-10 cm x 3-10 mm crassa plerumque unicostata. Cymæ saepe tri-radiatæ. Pedunculus communis tenuis 2-3.5 cm. Pedicella gemmaeque longiores quam in typica. Fructus ovatus ad cylindræus 7-9 mm long, 5 mm diam.

Plants glabrous, usually pendulous, with slender branches, sometimes exceeding 3 feet in length and often forming dense masses. Union attachment more elongated than the typical form. Leaves narrow to broad linear or linear-oblong, 2-10 cm by 3-10 mm, thick, usually one-nerved, or some of the broader leaves faintly 3-nerved. Cymes frequently 3-branched, the common peduncle slender, 2-3½ cm long, pedicels and flowers longer than the typical form, otherwise the same. Fruit cylindrical-ovate, Amber Yellow (Fig 28, No 1-4), changing to Straw Yellow (Fig 31, No 1-4, Rep de Coul, Dauthenay), 7-9 mm long, 5 mm in diameter, crowned with the persistent calyx limb. Seeds obconic to elliptic, with a small spongy base, indistinctly 5-6-furrowed. Viscin white, copious, very sweet. Endosperm at first white, but on the germination of the embryo turns to a dark green, hypocotyl dark green, terete and verrucose, sometimes attaining 10 mm in length. Embryonic cotyledons narrow oblong, slightly broader at the top, 3 mm long.

This form appears to be more widely distributed than the normal form. It is very common throughout the western and north-western parts of New South Wales, and is also found in Queensland and South Australia.

This variety is relished by stock.

Range—*South Australia*: Mt Lyndhurst and Edinowie (in Adelaide Herbarium), *Victoria*: Lake Hindmarsh (on *L. Miquelii*, the latter on *Eucalyptus bicolor*); *New South Wales*: Broken Hill (on *Acacia cana*), Nulty-Toorale, Paroo R., Paldrumattia Bore, Wilcannia (on *Eremophila Stuartii*), Bourke (on *Myoporum platycarpum*, *Ventilago viminalis*, *Geijera parviflora*), Shuttleton (on *Geijera parviflora*), Cobar (numerous hosts), Mount Hope (on *L. Miquelii*, the latter on *Eucalyptus hemiphysa*), Gilgunnia (on *G. parviflora*), Wittagong, Car-gelligo-Condobolin, West Rogan (on *Fusanus acuminatus*), Coolabah (on *G. parviflora*), between Boggabri and Narrabri (on *L. inophyllus*, the latter on *Casuarina lepidophylla*), Narrabri West (on *L. Miquelii*, the latter on *Eucalyptus*

populifolia), Nariabri Queensland Diamantina R (in Queensland Herbarium), Bulloo R (on *Leucanacum acuminatus*). Aramac, Murrumbidgee (on *Santalum lanceolatum*), Jericho

Differing from *L. miraculosus* Miq in the longer and narrower leaves and in the longer peduncles pedicels and buds

It is a larger, coarser, and more pendulous plant than var *Melaleuca*, with relatively longer leaves and buds

Named in honour of John Luke Boorman, Botanical Collector, Botanic Gardens, Sydney

Hosts—Casuarinaceae *Casuarina Luehmanni* R T Baker Santalaceae *Fusanus acuminatus* R Br, *Santalum lanceolatum* R Br Loranthaceae *Loranthus Miquelii* Lehm, *L. knopphyllus* Fenzl Leguminosae *Acacia aneura* F v M, *A. cana* Maiden, *A. excelsa* Benth, *A. harpophylla* Cunn, *A. homalophylla* A Cunn Rutaceae *Plundersia maculosa* F v M. *Geijera parviflora* Lindl Rhamnaceae *Entilago uminalis* Hook Myrtaceae *Eucalyptus bicolor* A Cunn, *E. hemiphylloia* F v M Myoporaceae *Fremophila Mitchellii* Bth, *E. Stuartii* R Br, *Myoporum platycarpum* R Br

(c) Var *PUBIGERA*, n var (Plate VII, figs 8, 9.)

Surreuli gemmaeque pilum rufum praebunt Folia angusta ad lato-lanceolata subacuta 3-costata in brevem teretem petiolum attenuata Cymae bi-radiati Gemmae graciles Bracteae calycesque fimbriati pilis mollibus Basis calycis dense cinereo-tomentosa Stylus tenuis apice fere contorto Stigma capitatum

Leaves narrow to broad lanceolate usually, somewhat acute, 3-nerved, 1-3 inches long, tapering into a short terete petiole Young shoots and buds minutely hoary or partly rufous pubescent Cymes 2-branched, buds slender Bracts and calyces fringed with a rather conspicuous border of soft hairs, base of calyx densely hoary Style very slender, almost spirally twisted at the top, stigma capitate

Differing from var *Boormanii* in the vestiture of the buds and nascent parts, and, like it, the peduncles and pedicels are not carinose as in the typical *L. miraculosus*

The style is more twisted at the top than the preceding, and it is also longer, and the stigma is larger

Loc - 35 miles west of Cobar (on *Eucalyptus* sp and *Acacia homalophylla*, L. Abraham, No 801, 6, 1912)

Hosts—Leguminosae *Acacia homalophylla* A Cunn Myrtaceae *Eucalyptus* sp

13 LORANTHUS GALDICHAUDI DC (Plate VIII)

Prod Syst Veg, iv, 1830, 295, non Hugel, Benth, B.Fl, iii, 1866, 594, as *L. pendulus* Sieb, var *parviflorus* (in part), Etting, Über die Blatts der Lor, 1877, Taf 11, Fig 15

The following is a translation of the original description by G Don in Gen. Hist, iii, 419, as *Dendrophthoe Gaudichaudi* glabrous, branches terete; leaves opposite, linear, obtuse, thickish, attenuated at the base, peduncles axillary, much shorter than the leaves, divaricately bifid at the apex, 2-4-flowered; parts of flowers equal; flowers tetrandrous, petals spatulate, anthers ovate, inserted by the base. H P G Native of New Holland, where it was collected by Gaudichaud.

Loranthus Gaudichaudi, DC prod 4 p, 295. Leaves 10-12 lines long, and 2 lines broad. Flowers 5-6 lines long. Style filiform."

The following is a more detailed description.—Small compact shrubs with a ball-like union, forming globular masses, 6-36 inches in diameter, usually forming on the ends of the branches of the host. Young branches and leaves infested with a minute ferruginous deciduous vestiture, old branches lenticular-scabrous, and marked by the prominent scars of the petioles. Adult leaves glabrous, opposite, or occasionally a few alternate, linear-cuneate to spatulate or oblong-lanceolate, obtuse, one-nerved with very obscure lateral veins, tapering into a semiterete, 3-5 mm petiole, usually 2-3 cm long, sometimes exceeding 4 cm., the margins very thin. Cymes slender, chiefly axillary, usually 2-3-branched, each branch bearing 3 flowers, the central flower of each triad sessile, the lateral one on short slender pedicels. Flowers crimson-purple, smaller than *L. mirabilis*, buds clavate, minutely scurfy as well as the floral branches, 10 mm long, very slender, bracts small, navicular, ciliate, segments 4-5, free, linear, crimson. Filaments and style the same colour as the segments. Anthers adnate, ovate, 1-2 mm long. Style slender; stigma capitate, rather large. Fruits globose bright red, 3-4 mm in diameter. Seeds elliptical, 2 mm long, the base somewhat spongy, indistinctly 4-furrowed. Endosperm white, except the base which appears to be constantly pinkish. Hypocotyl green, lengthening out to about 5 mm, with a few prominent tubercles. Disc somewhat conical. Embryonic cotyledons linear obtuse, to semiterete, not withdrawn on germination. Primary leaves linear, obtuse, thick, 2-4 mm long.

It is not quite clear where Gaudichaud collected the plant which bears his name, as he collected plants on the West Coast, Port Jackson, Botany Bay, and the Blue Mountains (*vide* F. M. Bailey, Proc. Roy. Soc. Q'land, viii, 1889-90, 22).

It is most likely that the specimens were collected in the Port Jackson district, as the species is common along the Parramatta River, in the vicinity of Parramatta. Most of these places were easy of access to the early botanical collectors.

So far, I have not seen specimens of this species from Western Australia. The *L. Gaudichaudi* of Hugel (*Plantae Novae Hollandiae*, 1848, 56) is, in my opinion, a form of *L. inophyllus* Fenzl, as the description is applicable to it.

The leaves of *L. Gaudichaudi* DC figured by Ettingshausen (*Über Die Blattkelette der Loranthaceen*, Taf. II, Fig. 15) cannot be separated from many specimens both in shape and venation over a large range of specimens from Port Jackson and other districts.

Bentham does not refer to *L. Gaudichaudi* DC in the "Flora", he evidently overlooked it, as it is referred to by Mueller in his Report of the Burdekin Expedition (1860), which is quoted by Bentham in the "Flora".

It appears to me that Woolls' specimens from Parramatta, quoted by Bentham under *L. pendulus* Sieb. var. *parviflorus*, are referable to *L. Gaudichaudi* DC or *L. congener* Sieb., as both species are plentiful in the above locality. It is quite possible that he also regarded the Parramatta plant as *L. mirabilis* Miq. or *L. Melaleucas* Lehm.

Had he ample material of these species, especially the fruits, I am confident that his decision would have been different.

Mueller (Report Burdekin Expedition) refers to this species as follows: "An extreme form seems the *L. Gaudichaudi*, varying with 4 and 5 petals, having the leaves and flowers reduced to remarkable smallness, and the anthers by diminution of length altered to an ovate form."

The only other record I am able to trace of this species in Australian literature is by Wools (A contribution to the Flora of Australia, Botany of Ash Island, 1862, 187) He says "*L. Gaudichaudi* DC grows principally on *Melaleuca*"

Synonyms—*L. pendulus* Sieb var *parviflorus* Benth (in part), *Dendrophthoe Gaudichaudi* G Don

Range—This species is so far confined to New South Wales, and appears to be restricted to the coastal range, extending from Thirlmere, South of Sydney, to the Queensland border Its appearance can be looked for in the northern State

New South Wales Thirlmere to Granville, Parramatta to St Mary's and Richmond, Homebush to Rhodes, Lakemba, Penshurst, Dorrigo Forest Reserve, Acacia Creek, Ash Is, Clarence River

Affinities—Its closest affinity is *L. miraculosus* Miq var *Melaleuca*, from which it can be distinguished by the minutely pubescent young parts, buds, and smaller flowers with their corresponding frailer and smaller peduncle and pedicels, also in the small globose fruit

From *L. miraculosus* Miq, it is distinguished by the preceding characters and in the smaller, one-nerved, narrow, cuneate leaves The bright red fruits of *L. Gaudichaudi* bear some resemblance to the fruits of *L. Preissii*, *L. Cambagei*, and *L. knopphyllus*, the latter three are terete-leaved species

Phrygilanthus Bidwillii would easily pass for this species when in fruit, as the foliage of some forms and the fruits are remarkably homoplastic, but the bifurcate peduncle, if present, is a distinguishing character The anthers of course are different in both

The common host-plant of *L. Gaudichaudi*, according to Mr E Cheel who has revised the genus *Melaleuca*, is *M. gemustifolia* Sm, and not *M. parvifolia* Lindl., as generally accepted

In the George's River district, this species forms dense compact masses, sometimes completely smothering the host to within a foot of the ground It is in easy reach of cattle, but they do not appear to eat it

Hosts—Loranthaceae *Loranthus pendulus* Sieb, *L. congener* Sieb Myrtaceae *Melaleuca gemustifolia* Sm, *M. stypheloides* Sm

14 LORANTHUS PREISSII Miq (Plate ix)

Lam, Plant Preiss, 1844-5, 280, Walp, Rept Bot Syst, v, 1845-46, 938, Miq, Ned Kruidk Arch, iv, 1856, 105, Benth, B Fl, iii, 393 in part, forma (n), Wild, Pl Nov Then, ii, 1909, Pl 76, Engl, Engl et Prantl, Pflanzenfam as *L. knopphyllus* Fenzl

The following is a translation of the original description—Glabrous, branches terete, leaves subopposite terete, filiform, somewhat straight, subacute or blunt, fleshy or succulent Flowers on axillary two or three branched cymes shorter than the leaves, pedicellate, or the central one sessile, calyx shortly obconic, the limb uneven Petals 5, linear-spathulate, concave at the apex, stamens inserted on the upper quarter of the petals, of equal length and a little shorter than the filiform style which is thickened upwards

Parasitic on *Acacia* sp near Perth, flowering, 8 3 18 Herb Preuss No 1611

Similar to the preceding (*L. Casuarinae*), but the inflorescence and flowers very different in shape Branches and branchlets terete, straight, alternately forked, glabrous, smooth, dark green Leaves straight or curved, 4-5 cm long,

somewhat terete, wrinkled and somewhat rigid when dry, bluntish or acute, 1-2 mm thick. Flowers cymose, the partial cyme two- or three-branched, supported on pedicels about $\frac{1}{2}$ cm long, the central flowers sessile, bracts flesh-coloured, ovate, acute, navicular, glabrous, or the apex somewhat ciliate or torn, dark brown in a dry state, the peduncles $2\frac{1}{2}$ cm long. Buds cylindrical-clavate, a little inflated at the base, somewhat straight, the apex thick and obtuse. Calyx shortly ob-conic, somewhat cupular, 2 mm long, the limb truncate or uneven. Petals 5, linear, the apex elliptical, dilated, somewhat acute, concave, stamens inserted a little below the expanded portion, anthers linear-spathulate, acute, 3 mm long. Style filiform, slightly exceeding the petals, thicker towards the base, stigma scarcely capitate, somewhat truncate.

Additional notes—Glabrous compact shrubs, 1-3 feet in diameter, union ball-like, branches pendulous, terete, 1-4 feet long, leaves opposite, alternate or in clusters of 3 or 4 on the same specimen, terete or somewhat compressed, mostly slender, straight or curved, acute, $1\frac{1}{2}$ to 4 inches long. Inflorescence cymose, glabrous, cymes 1-3 together on the nodes of the old and young branches, peduncles slender, $\frac{1}{4}$ to 1 inch long, considerably thicker at the base, usually only 2- or 3-branched, each with a partial cyme of 3 flowers, the central flower of each triad sessile, the lateral flowers on slender pedicels 5-9 mm long, bracts concave, navicular, ciliate on the margin, about as long as the calyx, but sometimes exceeding it, calyx cupular, the limb minutely denticulate-ciliate, and often undulate.

Buds robust, reddish, 1 inch long, clavate at the top, angular or scarcely terete towards the base, the latter abruptly inflated to a diameter greater than the calyx, causing the rim of the calyx to bulge over the solid portion of the calyx. Petals 5-6, yellowish in the upper portion, reddish towards the base, narrow-spathulate to lanceolate from the insertion of the filaments upwards, very narrow to within 4-5 mm of the base, then abruptly broader than the top. Filaments dark red, the adnate portion compressed and enlarged near the base, causing the corolla to become abnormally inflated at its junction with the calyx, the free portion about as long as the anthers. Anthers oblong, 3 mm long, pollen grains bright yellow. Style angular, geniculate about 3 mm below the stigma, and gradually narrowed upwards, stigma flat or repand. Fruit glabrous, globose, white, spotted red or flesh-coloured, often changing to a dark red and, according to Mueller, about the size of a pea (*vide* Trans Vic Institute, 1854-55, 128).

Disc fleshy, raised around the base of the style, obscurely 5-angled, and conspicuous on the ripe fruit. Seeds narrow elliptical, faintly 5-ribbed, 4-5 mm long. Endosperm white, bony when dry, hypocotyl terete, verrucose, disc conical. Embryonic cotyledons narrow, spathulate, thick, 3 mm long, not withdrawn from the endosperm on germination.

Synonyms—*L. Preussii* Miq, varietas ? Miq (1c). I have not seen Miquel's specimen but, judging from the description, it appears not to vary to any great extent from the typical form, which is fairly uniform, and in a large series of specimens the leaves are alternate on some branches and opposite on others on the same specimen. The flowers are also much brighter when exposed, than those collected in shady places. So far I have not seen a specimen differing materially in any characters from the typical form from Western Australia. *L. scoparius* Miq (1c) I am inclined to regard as a synonym of *L. Preussii* Miq. It appears to have been described from imperfect material. Mueller (Rept. Burd. Exped.), when discussing *L. scoparius*, states that it is the same as *L. Preussii*.

Range—The South Australian localities quoted by Bentham (1c) are in all probability referable to *L. Preussii* Miq, as all the authenticated specimens ex-

annum by me from S A proved to be this species, and, strange to say, I have not seen a single specimen of the typical *L. inophyllus* Fenzl from South Australia.

Western Australia Avon and Irwin Districts (frequently on *Acacias*), York (on *Acacia acuminata*), Gin Gin (on *A. cyanophylla*), Mingnew (on *Acacia* sp.), Ernest Giles Range (on *Acacia aneura*, also recorded in Trans Roy Soc S Aust. xi, 1892, 360 as *L. inophyllus*), Strelley R (on *Acacia colletioides*) **South Australia** Upper Coolangorina Creek (on *Acacia aneura*, recorded as *L. inophyllus*), Sandhills, Lake Hart (on *A. aneura*), L Eyre, Cooper's Creek, Lake Australia (on *A. melanoxydon*), Dublin Scrub, Myponga, Lyndhurst, Leigh's Creek, Tallacallana Creek (on *A. stenophylla*), Bunda Plateau, Crystal Brook, Roberts Town, Clarendon (on *A. melanoxydon* and on *L. pendulus*), Androssa, Barossa and Mt Lofly Range (on *A. melanoxydon* and *A. retinodes*), Murray R to Spencer's Gulf, Overland Corner (on "Needle *Acacia*") **Victoria** Toronto (on *A. retinodes*), Hawkesdale, Grampians (on *A. decurrens*) **New South Wales** Darling R near Wentworth (on *A. tetragonophylla*), Broken Hill (on *A. aneura*, *Myoporum platycarpum*, *A. tetragonophylla* and *A. aneura*), Cobar (on *Acacia* sp.), Gunbar (on *A. Oswaldi*), Tibooburra (double parasitic with *L. Exocarpi* on *A. tetragonophylla*), **Queensland** North from Broken Hill, Diamantina. **Northern Territory** Dalhousie Springs (on *Acacia* sp.), Dalhousie Station (on *A. saligna* var *varians*, recorded as *L. inophyllus*), Idracowra, Finke R, G of Carpentaria.

It will be seen that *L. Pressii* is recorded for all the States of the mainland, and is found not only in the coastal districts of Western Australia, but is also plentiful in Central Australia, which is probably its home. The palatable fruits are eagerly eaten by many birds which, no doubt, accounts for its wide range. Its flowering season appears to be from December to March. It is very singular that collectors have only noted this species growing upon *Acacia*, except in one instance, when it was found on *Myoporum platycarpum*.

The three specimens from Victoria, the only ones I have seen from that State, vary from those of the other States in the more slender foliage and slightly smaller flowers. The most robust and most handsome specimens are those from Central Australia, in which the petals are highly coloured.

Affinities—*L. Pressii* Miq differs from *L. inophyllus* Fenzl in being strictly glabrous, both in foliage and flowers, the latter are more highly coloured, and the corolla is less angular and more inflated at the base, the fruits also are larger, glabrous and less contracted at the top than those of *L. inophyllus* Fenzl.

L. Pressii Miq is also closely allied to *L. Cambagei*, from which it differs in the shorter and glabrous leaves, larger and more robust glabrous buds, differently shaped calyx, and in the larger and more highly coloured fruits.

According to Max Koch (Trans Roy Soc S A, xxi, Part ii, 1898, 101), the native name of this species is Partapee.

Hosts—Loranthaceae *Loranthus Exocarpi* Behr, *L. pendulus* Sieber Leguminosae *Acacia acuminata* Benth, *A. aneura* F v M, *A. colletioides* A Cunn, *A. cyanophylla* Lndl, *A. decurrens* Willd, *A. Lehmanniana* F v M, *A. melanoxydon* R Br, *A. Oswaldi* F v M, *A. retinodes* Schlecht, *A. saligna* Lndl var *varians* Benth, *A. sentis* F v M, *A. stenophylla* A Cunn, *A. tetragonophylla* F v M Myoporaceae *Myoporum platycarpum* R Br

Var *INDYMA*, n var (Plate ix, fig 9)

Glaber, ramis teretibus, foliis teretibus, pedunculato 2-floribus, 5 mm longo; pedicellis gracilibus leviter compressis 6-8 mm longis, alabastris formae typicae similibus, 13 mm longis. Calyce obconico limbo repando, fructum non vidi.

Flowers in pairs on slender, slightly compressed pedicels, 6-8 mm long, the common peduncle 5 mm long. Buds similar to the typical form, 13 mm long. Calyx in the spent flowers conical. Fruit not seen. Queensland, Diamantina, Dr T. L. Bancroft, April 1892, No 1078.

The only specimen seen of this variety is somewhat fragmentary, but the didymous inflorescence is a striking contrast to the typical triflorous cymose inflorescence of this series, and is apparently constant, when in bud, it is somewhat similar to *L. Mitchelliana*, but the flowers are not tubular, the segments are separable to the base. The common peduncle appears to be articulate in the middle, if this is so, it is unusual in this series. On the other hand it may be bifurcate in perfect specimens. It gives the impression of a secondary peduncle, but from the scant material it is difficult to come to a definite conclusion. Further field observations are necessary to define it clearly.

15 *LOBANTHUS CAMBAGLI*, n sp. (Plate x)

Quoted by Benthain (B Fl, iii, 393) under *L. linophyllus* Fenzl as (b), "with slightly tomentose flowers from Brisbane to Port Jackson and Illawarra."

After a careful comparison with *L. linophyllus* Fenzl, and taking into consideration its wide range, and the numerous specimens which came under my scrutiny, together with my field knowledge of the plant, I feel justified in raising it to specific rank.

Frutex plerumque densus cinereus pendulus globosus ramis tenuibus glabris nisi minute tomentosis apicibus. Folia teretia gracillima 3-8 unc longa. Inflorescentia cymosa cymis axillaribus aliquanto tomentosis 2-4 ramatis utroque 3 floribus centrali sessili. Gemmae porriginosae graciles 1.5-2 cm longae. Corolla petalis subtilissima. Filamenta basi non calcarata. Antherae adnatae oblongae 2 mm longae. Fructus globosus fere glaber colorem carnis exhibens 3-5 mm diam.

Usually compact, pendulous, ashy-grey shrubs with a ball-like union, and slender glabrous branches, except for the very young parts which are minutely tomentose, this passing away with age, 2-4 feet long, forming a mass 1-4 feet in diameter. Leaves very slender, the young ones slightly tomentose, glabrous when fully developed, opposite, alternate, occasionally in little clusters of 3 or 5, terete, wrinkled, 3-8 inches long, acute or with a small oblique mucro. Inflorescence cymose, cymes axillary, occasionally terminal on very old plants, the common peduncle terete, 1½-2 cm long, or longer, bearing an umbel of 2-4 rays, with a partial cyme of 3 flowers, the central one of each triad sessile, the lateral flowers on short pedicels. Bracts minutely pubescent, narrow, acute, calyx cupular, very small, tomentose at the base, the limb ciliate and almost glabrous. Buds slender slightly tomentose, terete, clavate at the top, the base somewhat inflated, under 2 cm long. Petals 5, free for their entire length, very thin reddish to purple-brown inside, flesh-coloured or hoary pink outside, narrow-lanceolate, often with a central line. Filaments reddish, the free portion compressed, 5 mm long, anthers adnate, narrow-linear, or linear-oblong, 2 mm long. Fruit globose, crowned with the persistent calyx-limb into a very short tube, frosted or minutely tomentose, pearl-white to flesh-colour, 3-4 mm in diameter, disc circular, conspicuous. Seed elliptical, with 5 scarcely prominent furrows around it, the base spongy, the elastic horns, corresponding with the 5 furrows, very thin, exceeding the seed by about 1 mm. Endosperm white, hard and bony when dry. Hypocotyl very slender, verrucose, suctorial disc flat. Embryonic cotyledons narrow-

linear, obtuse, not withdrawn on germination, primary leaves semi-terete, acicular

The description is drawn up from specimens from Grose River and banks of the Nepean, near its confluence with the Grose, parasitic on *Casuarina Cunninghamiana* Miq., J. H. Maiden and R. H. Cambage, No 758, 9, 1906. Robert Brown collected at this spot about May, 1803, and January, 1805, his specimens are referred to by Bentham (*l.c.*)

Named in honor of Mr R. H. Cambage, who for many years has taken a keen interest in the native flora, and has contributed many valuable specimens to the National Herbarium

Synonym—*L. linophyllus* Fenzl var. *purviflorus* A. G. Hamilton (Proc Linn Soc N.S.W., 11, Second Series, 1887, p. 282) is probably the same as *L. Cambagei*, but as there is no description or specimen in existence, its identity cannot be confirmed

Range—*New South Wales* Burrinjuck and Taemas Bridge, south of Yass (on *Casuarina Cunninghamiana*), Narrandera, Barmedman (on *C. lepidophloia*), Bowan Park, near Cudal (on *C. Cunninghamiana*), Trangie and Nyngan (on *C. lepidophloia*), Nepean and Grose Rivers (on *C. Cunninghamiana*), Newport to Barrenjoey (on *C. glauca*), Agnes Banks Windsor (on *C. suberosa*, *Melaleuca linearifolia* and a cultivated plum), Tuggerah Lakes (on *C. glauca*), West Maitland, Belmont (on *C. glauca*), Tilligerry, near Booral, Mudgee and Dubbo (on *C. sp.*), Narromune (on *C. Luehmanni*), West Bogan (on *Casuarina* and *Eremophila Mitchellii*), Bugaldie (on *C. Cunninghamiana*), Warrumbungle Ranges, 20 mls N.E. of Boggabri (on *C. Cunninghamiana*), Narrabri (on *C. lepidophloia*), Yarrawin Station, Barwon River, Warialda (on *C. lepidophloia*), Casino (on *C. torulosa*), Richmond R. (on *C. glauca*), Kyogle (on *Eugenia Smithii*), Wallangarra *Queensland* Brisbane R. (on *Casuarina*), Bulimba (on *Notothizos subaurea*, the latter on *C. glauca*), Burpengary, Imbil (on *C. Cunninghamiana*), Surat, Stannary Hills, Evelyn, Herberton (on *C. torulosa*)

At Bowan Park, near Cudal, this is the most common *Loranthus* frequenting *Casuarina Cunninghamiana*, and occasionally parasitic on *L. pendulus* and *L. Miquelii*. It is strikingly constant in its characters, as no marked variation was observed by me in the numerous plants throughout the district. The absence of *L. linophyllus* from this particular district is also very marked. In the fruiting season it is visited by many frugivorous birds which are particularly partial to its small juicy fruits. The following have been noted by me feeding upon its fruits—Mistletoe-Bird, *Dicaeum hirundinaceum* (*vide* Leach, No 336), Golden Rumped Diamond-Bird, *Pardalote xanthopygus*, No 341, Silver-eye, *Zosterops coerulescens*, No 334, Soldier-Bird, *Myzantha garrula*, No 368, Leather-head, *Tropidorhynchus cormiculatus*, No 374, Rosella, *Platyocercus eximius*, No 202, Cockatoo-Parrot, *Calopsoptacus novae-hollandiae*, No 196, Galah, *Cacatua roseicapilla*, No 194

Affinities—*L. Cambagei* is closely allied to *L. linophyllus* Fenzl, from which it differs as follows—

L. Cambagei, n. sp.

Branches glabrous, or the young shoots minutely pubescent, the pubescence passing away the first year

Leaves very slender, only the very young ones slightly tomentose, 2-8 inches long

Cymes slightly tomentose or scurfy, peduncles slender in proportion to the

L. linophyllus Fenzl.

Branches hoary-tomentose for two or more years

Leaves hoary, thick and coarse, sometimes becoming glabrous with age, 2-6 inches long

Cymes densely woolly-tomentose; the common peduncle short and stout, hoary-tomentose, 1½ cm long, usually

number of flowers, scantily pubescent, rarely less than 2 cm. long, lateral pedicels slender, 5-7 mm long. Flowers numerous

Buds slender, 1.5-2 cm long. Petals very thin.

Filaments terminating without a conspicuous spur at the base, 5 mm long, anthers 2 mm. long

Fruit globose, flesh-coloured, 3-5 mm. in diameter, nearly glabrous

1 cm, lateral pedicels stout, 3-4 mm long. Flowers few

Buds robust, 2-2.5 cm long. Petals thick

Filaments ending in a spur-like callosity at the base, the upper free portion 4 mm. long; anthers 3 mm. long

Fruit urceolate to elliptical, 5-7 mm in diameter, hoary-tomentose

From *L. Preissii* Miq., it is distinguished by its longer and more slender leaves; pubescent young shoots, slender mealy buds, and smaller fruits. The buds of *L. Preissii* Miq. are more inflated at the base than those of *L. Cambagesii*.

It is interesting to note that *L. Cambagesii* has not yet been found associated with *L. Preissii* Miq., and the latter species has not yet reached the eastern and north-eastern coast.

Hosts.—Casuarineae: *Casuarina Cunninghamiana* Miq., *C. glauca* Sieb., *C. lepidophloia* F. v. M., *C. Luehmannii* R. T. Baker, *C. suberosa* Ott. et Diet., *C. torulosa* Ait. Loranthaceae: *Loranthus pendulus* Sieb., *L. Miquelii* Lehm., *Notothax subaureus* Oliv. Rosaceae: Plum., var. *Lutherboro*. Myrtaceae: *Melaleuca linearifolia* Sm., *Eugenia Smithii* Pon.

16 LORANTHUS LINOPHYLLUS Fenzl (Plate xi)

Huegel, Enum., 1837, 56, Walp., Rep. Bot. Syst., ii, 443, Huegel, Pl. Nov. Holl., 189, Benth., B. Fl., iii, 393 (in part), Muell., Key Viet. Pl., i, 273; Moore and Betche, Fl. N. S. W., 228, Bail., Q. land Fl., Part v, 1380

Bentham and Hooker (Genera Plantarum, iii, 208) credit Presl with being the author of *L. linophyllus*, not Fenzl, which appears to be a mistake.

This is the forma (c) of Bentham (l.c.) "with woolly-tomentose flowers, in New England and West Australia."

I have not seen the original description, and, as Bentham's description includes more than one species and that of Huegel (though more accurate) is scarcely sufficient, I am obliged to re-describe it, and in so doing, take O. H. Sargent's No. 274, and A. G. Hamilton's No. 717, the latter is from Perth and the former from York, W. Australia, which is in the vicinity of the type locality.

Compact shrubs forming drooping masses 2-7 feet long, 1-3 feet in diameter, upon ball-like. Branches hoary tomentose when young, also the leaves, glabrous or almost so when old; leaves opposite, alternate, or in clusters of 3 to 6, terete, stout, rugose or wrinkled when dry, 1-6 inches long (usually 2-4 inches), straight or curved, mostly obtuse, occasionally acute. Inflorescence cymose, axillary, or springing from the nodes of the leafless branches. Cymes densely woolly, hoary-tomentose; the common peduncle short and stout, bearing 2 or 3 lateral or partial cymes, each with 3 flowers, the central flowers sessile; the lateral flowers on short woolly bracteate pedicels. Bracts fleshy, narrow-ovate to cordate, acute, sometimes exceeding the short calyx, calyx cupular, densely woolly-tomentose, the limb contracted and fully half the length of the calyx, closing over the disc after the petals fall. Buds robust, hoary-tomentose, angular in the lower half, clavate at the top, 2-2½ cm. long. Petals 4 or 5, free, reddish inside, thick, the upper portion spatulate, concave, with a tuft of rufous deciduous hairs inside beneath the acute apex, the lower portion uniformly narrow-linear, filaments

rather thick, compressed, ending in a spur-like callosity, 4-5 mm from the base, fringed on either side with a minute woolly tomentum, the apex jagged and somewhat ciliate, the free upper portion about 4 mm long. Anthers adnate, linear-oblong, 3 mm long, the cells conspicuous. Style angular or sulcate, rather firm, bent a little below the small, scarcely enlarged stigma. Fruit urceolate, densely tomentose, 5-8 mm in diameter, contracted at the top into a very short tube, disc conical without conspicuous angles. Seeds white, elliptical, with a small spongy base, 5-angled towards the top. Hypocotyl white, slender, verrucose, 5-10 mm long, suctorial disc rather large, embryonic cotyledons narrow-obtuse.

Range—This species, like its congener *L. Preissii* Miq., has been recorded for all the States by Benthams, but I have not seen a typical specimen of *L. inophyllus* Fenzl, from South Australia or the Northern Territory. In the compilation of its range I have, in some cases, quoted, without prejudice, the records of various authors, and it remains for botanists in those States to verify these records. I am influenced in my opinion that it does exist in those States, by the range of *L. Preissii* Miq., for it would be unnatural for it to appear in the western and eastern States and not in the central States.

In some of the Victorian and New South Wales specimens the flowers are densely-woolly white and almost sessile and, like all other species, the bracteate pedicels vary considerably in length.

Western Australia Swan River (Preiss Nos 1611, 1613, 1615, 1618, quoted by Benthams), Perth (on *Casuarina glauca*), York, Banks of Avon River (on *Casuarina* sp.), Irwin District, near Northampton (on *Casuarina* sp.), Siberia Soak, between Yilganna claypans and Pindinnie Soak (This may be *L. Preissii* Miq., but the author (Moore) does not state whether his plant is glabrous), Murchison, Shark Bay, Dirk Hartog's Isle, Ernest Giles Range, Sturt's Creek. *Northern Territory* Hermannsburg, Finke River (Trans Roy Soc S A, v, (1881-82), 31, also Report Horn Exped, Part iii, 160), Bay of Rest (quoted by Benthams, *loc. cit.*) *Queensland* Evelyn, near Herberton (on *Casuarina torulosa* Ait.), Bakakula, via Chinchilla (on "Forest Oak," *Casuarina* sp.), Warwick, Mount Perry, Moreton Bay. *New South Wales* Clarence River, (on *Casuarina lepidophloia*), near Narrabri (on *Casuarina Luehmannii*), between Boggabri and Narrabri (on *Loranthus miraculosus* Miq., var. (b), and on *Casuarina lepidophloia*), New England, Gungal (on *C. Luehmannii*), Telligerry, Booral, Eugowra (on *C. Luehmannii*), Narromine (on *C. Luehmannii*), Wittagoona (on *C. lepidophloia*), Ryrock District (on *C. lepidophloia*), Trig Station, Louth (on *Casuarina* sp.), Broken Hill, Banks of Campbell's Creek (on *Casuarina lepidophloia*), Barrier Ranges, South-Western N S W, Temora-Barmedman (on *C. glauca*), Lake Albert (on *C. lepidophloia*), Moama (on *C. Luehmannii*). *Victoria* Werribee, Port Phillip, Geelong District, North Creswick (on "Blackwood-trees," *Acacia melanoxylon*, but the mistletoe was not observed on any other plant, nor on the smaller second growths of the Blackwoods. The elevation is about 1430 ft), Dumosa (on "Bull Oak," *Casuarina Luehmannii*), Dimboola (on *Casuarina glauca*), towards the Junction of the Ovens River and the Murray (on *Casuarina* sp.).

Sargent (Ann Bot, xxxii, 1918, 216) gives an interesting biological note on this species.

Affinities—Its closest affinity is with *L. Cambagei*, from which it differs in its large, woolly-tomentose buds and flowers, thicker leaves and more urceolate and woolly-tomentose fruits.

In general appearance and in minor characters it resembles *L. gibberulus*

Tate, from which it is readily distinguished by its triads of flowers, free filaments, and less tomentose leaves

Hosts.—Casuarineae *Casuarina glauca* Sieb, *C. lepidophloia* F v M, *C. Luehmanni* R T Baker, *C. suberosa* Ott et Diet, *C. torulosa* Ait Lorantheae *Loranthus mirabilis* Miq var *Boormanii* Leguminosae *Acacia melanoxylon* R Br Myoporaceae *Eremophila Mitchellii* Benth

17 LORANTHUS CONSPICUUS Bailey (Plate XII)

Qland Agric Journ, xxvi, 1911, 198. Plate xx, Comprehensive Cat Qland Pl (Fig 448 bis), 464

A somewhat stout plant, the branches dichotomous, closely and irregularly ribbed, often of a glaucous colour between these reddish ribs, the nodes rather close and prominent. Leaves coriaceous, nearly or quite sessile, the larger ones $2\frac{1}{2}$ to 3 in long, $1\frac{1}{2}$ to $1\frac{1}{4}$ in broad, obliquely ovate, very blunt at the apex, tapering to the base from about the centre, margins entire, somewhat undulate, 3 to 5-nerved, the nerves slightly branched, the reticulation faint, the smaller leaves more numerous, oblong, or obtuse cuneate, sessile or very shortly petiolate, from 1 in to $2\frac{1}{4}$ in long, the margins even, usually 3-nerved. Flowers in axillary cymes, very dense and dark-coloured, sessile, the bracts and calyx clothed with hairs, hoary-white on the calyx, dark on the bracts. Bracts triangular, calyx-lobes minute. Petals free, 6 to 9 lines long, narrow.

Hab.—Eidsvold (Dr Thos L Bancroft)

Supplementary notes from specimens received from Dr Bancroft from the same locality

Inflorescence axillary, composed of 5 to 9 almost sessile cymes in the axils, or springing from the nodes of the old branches, often encircling the nodes. Cymes two-branched, each branch bearing three closely sessile flowers. The common peduncle hoary pubescent, about 3 mm long, becoming more elongated in fruit, in some specimens nearly 1 cm long and almost glabrous.

Bracts somewhat spreading, narrow lanceolate, concave, ciliate, nearly glabrous on the back, the persistent bract thicker than the deciduous ones. Buds glabrous, narrow cylindrical clavate, acute or obtuse, 15 mm long. Calyx cylindrical, the base densely hoary-tomentose, the rather large limb glabrous or nearly so, with an almost entire ciliate margin. Petals 5, greenish, divided to the base into narrow-linear spathulate segments, minutely downy along the inner margins, above the attachment of the filaments, deflexed after anthesis. Filaments compressed, green, terminating a purplish erect adnate anther about 1 mm long, style green, angular, stigma somewhat conical or scarcely capitate. Fruit urceolate to bottle-shaped, with a rather long neck, the inflated portion densely tomentose, 5 mm long, 3 mm in diameter. Epicarp hard and thick, seeds globose, viscin scanty. Hypocotyl green, rugose, endosperm green. Embryo clavate, the embryonic cotyledons spathulate when opened out, not withdrawn on germination.

Range.—*L. conspicuus* is a Queensland species, known only from Eidsvold and Broad Sound. The author points out that the Broad Sound specimen was "received several years ago from the Herbarium, Royal Botanic Gardens, Kew, and labelled *L. coronatus*, no authority, however was given for the name *coronatus*, which has since been applied by Engler to an African species."

Affinites.—*L. conspicuus* is allied to *L. Quandang* Landl., as suggested by the author, from which it is readily separated by the differently shaped leaves, almost sessile cymes in dense clusters, sessile flowers, and very dissimilarly shaped buds and fruits.

Some forms of *L. congener* superficially resemble *L. conspicuus* in the leaves, but the floral and carpological characters are very different.

L. Betchei has the characteristic inflorescence of this species, but it is considerably longer, the leaves are also much narrower.

Hosts.—Loranthaceae *Loranthus Quandang* Landl. var. *Bancrofti* Bail.
Rhamnaceae *Alphitoma excelsa* Reiss.

18. *LORANTHUS BETCHEI*, n. sp. (Plate xiii.)

Frutex glaber cæctus confertus, ramis teretibus lenticularibus paulum apud nodos tremantibus apices juveniles glabros præbuntibus. Folia opposita angusta ad late-spathulata vel obovata obtusa tripli-costata, petiolata. Inflorescentia cymosa, cymis biradiatis, utroque ramo 3 flores sessiles terente, pedunculus communis teres 8-12 mm longus pariter cinereo-tomentosus sicut pedicelli bracteati. Bracteae acutae naviculares obscure brunneae. Gemmae glabrae tenues 1 mm diam parum clavatae 20-25 mm longae. Calyx pyriformis 3 mm longis basi pubescens. Corolla 5-petalis liberis viridibus. Antherae adnatae angusto-lineares 1 mm longae. Fructus urceolatus cinereo-tomentosus 6 mm longus 4 mm diam.

Glabrous, erect, compact shrubs often of much the habit and general appearance of *L. congener* Sieb. Branches terete, lenticulate, slightly swollen at the nodes, the young tips quite glabrous. Leaves opposite, narrow to broad spathulate or sometimes elliptical in the Queensland forms, obtuse, triplinerved, the veins more prominent underneath and slightly depressed on the upper surface, the lateral ones obscure or wanting, usually drying a dark colour like *L. congener*, 4-8 cm long, 1-3 cm broad, tapering into a well defined petiole. Inflorescence cymose, cymes two-branched, each branch bearing 3 sessile flowers. The common peduncle terete, 8-12 cm long, slightly hoary-tomentose, as well as the 4 mm bracteate pedicel. Bracts acute, navicular, dark brown, somewhat coriaceous, almost glabrous, the central one persistent, the lateral ones deciduous, similar in every respect to those of *L. conspicuus*, but more glabrous.

Buds glabrous, slender, about 1 mm in diameter, slightly clavate, the demarcation lines of the segments slightly raised, giving the buds an angular appearance when dry, 20 to 25 mm long. Calyx pear-shaped, 3 mm. long, pubescent at the base with a hoary and rufous tomentum, the thin entire limb almost glabrous except for the minute red-brown ciliate border. Petals green, usually 5, free, marked along the entire length of the inner margin with a minute pubescence.

Filaments straw-coloured, compressed, attached to the centre of the segment, anthers adnate, narrow-linear, about 1 mm long. Style angular, with a scarcely enlarged stigma, disc raised around the base of the style. Fruit urceolate, hoary-tomentose except the somewhat long neck, 6 mm long, 4 mm. in diameter. Seeds globose, similar to those of *L. conspicuus*, the cotyledons are probably the same as in that species.

Habitus.—parasitic on *Alphitoma excelsa*, W. Bauerlen, No 942, 12, 1892. The type

Lake L. conspicuus Bail. this species is found on the brush timber of the North Coast, extending from Ballina to North Queensland

Range—New South Wales Ballina Queensland. Cairns, Yarrabah, near Cairns, Howick Group (referred to by Benthams in B Fl under *L. odontocalyx* F v M), Bundaberg

Affinities—*L. Betchei* has the characteristic inflorescence of *L. conspicuus*, but the common peduncle is much longer, exceeding 10 mm, whereas in *L. conspicuus* it is very short, almost obscure. The buds too, are longer, being twice the length of those of *L. conspicuus*, while the leaves are usually narrow oblong-cuneate, and fairly constantly triplinerved. Those of *L. conspicuus* are often quinquenerved, and on the whole coarser and more venulose.

The differences in the characters appear to me to be sufficiently distinct as to warrant specific rank. The Ballina and Cairns specimens, in spite of the great distance between the two localities, are inseparable, and lead me to believe that the characters are stable.

L. Betchei is similar to *L. congener* Sieb. in appearance, the two-branched cyme, smaller buds, sessile flowers, and different-shaped bracts are the points by which it can be distinguished from *L. congener*.

Named in honour of the late Ernst Betsche, late Chief Botanical Assistant, Botanic Gardens, Sydney.

Hosts—Rhamnaceae *Alphitoma excelsa* Reuss

(a) Var. *DUBLIA*, n. var. (Plate xiii, fig. 7)

Rami graciles teretes juveniles aliquanto minutae farinaceo ferrugineo tomentum induta. Folia opposita vel alternata ovato-lanceolata in brevem petiolum repente constricta obscure tripli-costata vel latiora quinque-costata 3-4 cm. longa, 1.5-2 cm. lata exsiccata obscure plumbea. Inflorescentia est cymus singularis pendulus duobus ramis ex axilla ortus. Flores non visi. Fructus juvenilis sessilis intra latas fere cordatas bracteis, dense cinereo-tomentosus atque magis cylindricus quam in *L. Betchei*.

Branches slender, terete, the young ones more or less covered with a minute, mainly ferruginous tomentum. Leaves opposite or alternate, ovate-lanceolate, oblong to elliptic, abruptly contracted into a short terete petiole, obscurely triplinerved or occasionally a few of the broader ones quinquenerved, 3 to 4 cm. long, 1.5 to 2 cm. broad, drying a dark lead colour, the petioles 3 to 7 mm. long.

Inflorescence cymose, consisting of a solitary 2-branched erect or pendulous axillary cyme. Flowers not seen. The specimen is in juvenile fruit only, which are sessile within the broad almost cordate bracts, and densely hoary-tomentose, and more cylindric in outline than those of *L. Betchei*.

Welsh River, T. Barclay Millar, March, 1891, Queensland Herbarium, kindly lent by Mr. C. T. White.

Perhaps a distinct species, resembling *L. Betchei* in the two-branched cyme and in the sessile arrangement of the inflorescence. The bracts are also broader than those of *L. Betchei*; and the tomentum on the young branches is another character which differentiates it from that species.

No doubt when more material of this plant is available, it will be found to possess other characters which will distinguish it from *L. Betchei* more definitely.

(b) Var. *TOMENTILIA*, n. var. (Plate xiii, figs. 8-10)

Rami aliquanto crassi partibus juvenilibus minute cinereis. Folia petiolata late-elliptica coriacea rugosa 3-5 costata ut plurimum 4-6 cm. longa 3 cm. lata. Cymus 3-8 in fasciculis bi ramatis ut in forma typica. Gemmae per contra haud

glabrae sed minute cinereo-tomentosae Bracteae quoque latiores et magis carnosae

Branches rather stout, the young parts minutely hoary, leaves broadly elliptical, coriaceous, rugose, 3—5-nerved, the largest 4-6 cm long, 3 cm broad, petiolate

Cymes in clusters of 3-8, two-branched as in the typical form but the buds minutely hoary-tomentose, instead of glabrous, the bracts are also broader and more carnosae

Sweers Island, Gulf of Carpentaria, J F Bailey, 6 1901 In Queensland Herbarium I have only seen one specimen, but it seems so distinct from *L. Betchei* that I have no hesitation in giving it a name

It is a coarser and apparently larger plant than var *dubia*, and also differs from it in the clustered cymes

19 *LORANTHUS OBLIQUA*, n sp (Plate XIV)

Vitex glabre plerumque ramis teretibus pallidis Folia opposita sessilia oblongo cuneata ad elliptica aliquanto obliqua 3-costata 2-4 cm x 1.5-2 cm Inflorescentia cymosa cymis biradiatis utroque radia 3 flores centralem sessilem pinnabente Gemmae graciles teretes acutae clavatae 20-23 mm Calyx cylindricus Corolla 5 petalis, liberis Filamenta compressa Antherae lineares adnatae Stylis tenuis angularis Stigma sub capitatum Fructus urceolatus

Glabrous except for a minute rufous tomentum in the axils of the leaves and at the base of the inflorescence Branches terete, slightly swollen at the nodes, pale coloured Leaves opposite, sessile, but not stem-clasping, oblong cuneate to elliptical, somewhat oblique, coriaceous, 3-nerved, much paler on the lower surface, 2.4 cm long, 1.5 to 2 cm broad Inflorescence cymose, cymes two-branched, each branch with 3 flowers, the central one sessile, the lateral on pedicels 4-5 mm long, common peduncle slender, terete, gradually thicker towards the top, bracteate peduncles ciliate Bracts narrow, navicular, the minute membranous margin ciliate with rufous hairs Buds slender, terete, acute, clavate, 20-23 mm long Calyx cylindric, glabrous, except for the entire ciliate limb, 2-3 mm long Petals free, usually 5, acute, filaments compressed, attached about the centre of the petals, anthers linear, adnate Style slender, angular, usually bent in the upper portion, stigma sub-capitate Fruit urceolate

Johnstone River, North Queensland, Dr T L Bancroft Labelled *L. Quandang* Lindl var *amplifolius* in Brisbane Herbarium The type

It has also been collected at Yarrabali, near Canun, parasitic on Mangroves This specimen is in fruit, which is very similar to the fruits of *L. congener* Sieb, the leaves are also broader, more ovate and less oblique Both localities are on the North Queensland coast

Affinity—In the inflorescence *L. obliqua* shows a strong affinity to *L. Benthama*, but the leaves of both species are very dissimilar It has much in common with *L. Betchei*, from which it is distinguished by its almost sessile leaves

Host - *Verbenaceae Aicennia officinalis* L

EXPLANATION OF PLATES III-XIV

Plate III

Loranthus queenslandicus, n sp

- 1 Portion of flowering branch (nat size), 2 Bud, enlarged, 3 Flower, enlarged, 4, 5 Bracts, showing variation, 6 Calyx, showing the depressed disc 7 Fruit (nat size)

Plate IV

A *Loranthus Cygneus-Sinus*, n sp

1. Flowering branch (nat size), 2 A bud, 3 Flower, 4 5 Anthers, front and back view 6 A spent calyx with the rather thick style

B *Loranthus Mackayensis*, n sp

- 7 Flowering branch (nat size), 8 A bud, 9, 10 Anthers, front and back view, 11 Calyx with style attached

Plate V

Loranthus miraculosus Miq

- 1 Flowering branch (nat size), 2 Bud, enlarged, 3 Flower, enlarged 4 Anthers, enlarged, 5 Fruit, slightly enlarged 6 Lower portion of segment

Plate VI

Loranthus miraculosus Miq, (a) var *Melaleucæ* (Tate), nov comb

- 1 Flowering branch (nat size), 2 Bud, 3 Lower portion of segment

Plate VII

Loranthus miraculosus Miq (b) var *Boormanii*, n var

- 1 Flowering branch, Cobar (L Abraham, No 774), 2 A bud, 3 Fruit (nat size), 4 A germinating seed with two radicles, 5 Embryo, enlarged 6 Embryo with the cotyledons opened out, 7 Lower portion of segment showing the basal spur, which is more prominent on some segments than others, 8, 9 Bud, calyx and style of (c) var *pubigera*, n var

Plate VIII

Loranthus Gaudichaudi DC

- 1 A young flowering plant (nat size), 2 Bud, enlarged, 3 Flower, enlarged, 3a Base of segment showing callosity, enlarged 4 Anthers, front and back view, 5 Bracteate pedicel, 6 Fruit (nat size, and slightly enlarged) 7 Seed (nat size), 8 Seed, enlarged, 9 Germinating seed with two radicles 10 Germinating seed, enlarged, 11 An advanced seedling showing the linear-obtuse primary leaves

Plate IX

Loranthus Preussii Miq

- 1 Flowering branch (nat size), 2 Bud, enlarged 3 Flower, enlarged, 4 Segment, enlarged, 5 Fruit, enlarged, 6 Seed (nat size), 7 A young seedling with the endosperm removed showing the cotyledons, 8 An advanced germinating seed, enlarged 9 var *didyma*, n var

Plate X

Loranthus Cambagei, n sp

- 1 Flowering branch (nat size), 2 Bud, enlarged, 3 Flower, enlarged, 4 Base of segment, enlarged, 5 Fruit (nat size), 6 Germinating seed, enlarged, 7 A seedling (nat size), probably in its second year

Plate XI

Loranthus knopphyllus Fenzl

- 1 Flowering branch (nat size) 2 A triad of sessile buds 3 A bud, enlarged, 4. Flower, enlarged, 5 Bracts, enlarged, 6 Lower portion of segment showing the spur-like callosity, 7 Segment of a flower from Queensland, showing a slightly hirsute filament and different-shaped callosity at the base, 8 Fruit (nat size).

Plate xii

Loranthus conspicuus Bail

1 Flowering branch (nat size), 2 Bud with deciduous bract attached, 3 A cymule showing 3 buds and 3 calyces, 4 Flower 5 Anthers front and back view 6 Fruit (nat size) 7 Fruit, enlarged, 8 Germinating seed, enlarged

Plate xiii

Loranthus Betcher, n spA *L. Betcher*, n sp

1 Flowering branch (nat size) 2 Bud, enlarged 3 A segment with stamen attached 4 Anther 5 Style, 6 Two leaves and fruit, Howicks Group (F Mueller)

B *L. Betcher*, var *dubia*, n var

7 Fruiting twig (nat size)

C *L. Betcher*, var *tomentula*, n var

8 Leaf and cyme (nat size) 9 Bud enlarged 10 A broad leaf, Sweet's Island (J F Bailey)

Plate xiv

Loranthus obliqua, n sp

1 Flowering branch (nat size) 2 Common peduncle and secondary peduncles, 3 Bud, 4 Flower 5 Anther 6 Fruit

SOME NOTES ON THE PERMO-CARBONIFEROUS AND OVERLYING SYSTEMS IN CENTRAL QUEENSLAND *

By H I JENSEN, D Sc

(Read 18th April 1923)

1 *Introduction* The writer has for the past eighteen months been carrying on geological reconnaissance work in the country lying between the Charleville Railway line and the Longreach Railway line in Western Queensland. He is in consequence in a position to offer some remarks on the sequence of formations within the area. An advance account of the general geology of the region has already been published by the writer in the Queensland Government Mining Journal for the months of March, August and October, 1921. The present paper is only a brief summary of results.

2 *The Geological Sequence in the Carnarvons* The entire area examined by the writer is for the sake of convenience referred to as the Carnarvons. The rocks represented in the area include volcanic, plutonic and sedimentary rocks ranging from metamorphic to recent. The igneous rocks it is not proposed to discuss here, except that it might be stated that the volcanic rocks of the Carnarvon Range, Dividing Range and Springsure areas are chiefly Tertiary, the only other volcanics noted being those of Lower Bowen and Star age, together with some tuffy sedimentaries in the Ipswich Series.

The oldest sedimentary rocks are metamorphic schists and serpentines of undetermined (perhaps Devonian) age, outcropping over a few small isolated areas as buried pinnacles recently exposed by denudation.

The next rocks in point of age are those of the Star Formation, which are taken to be Lower Carboniferous ranging to Middle Carboniferous. The Lower Star rocks are sandstones with abundant *Lepidodendron veltheimianum* and interbedded basic lavas.

At Mt Budge, Drummond Range, a specimen of *Anomites australis* has been obtained and the higher Star Beds are mudstones and shales of marine origin, with abundant fish remains. The Star Beds are considerably folded, and are the equivalents of the Burin Series in New South Wales.

*This paper is published with the understanding that the views expressed are those of the author and are not necessarily endorsed by the Queensland Geological Survey by whom he was employed at the time of making the observations.—Ed

Lying unconformably on the Stai Beds we have the Lower Bowen Series, outcropping along the Nogoa River from Nandowrie Peak to Springsure. It consists of conglomerates, largely glacial, tillites, shales (including some highly contorted varve-shales), volcanic rocks (both basic and acid, with abundant prehnite and other zeolites) and, forming the top of the formation, a limestone containing an abundant fauna, including *Eurydesma cordata*. These rocks are the equivalents of the Kuttung Series.

Conformably resting on the Lower Bowen Series we have the Middle Bowen, consisting of a lower conglomeratic sandstone, a middle formation of shales with important coal measures (Consuelo Measures), and an upper sandstone with frequent red ferruginous sandstone bands. The coal beds and shales contain both *Glossopterus* and *Gangamopterus cyclopteroides*. The Middle Bowen Series fringes the Lower Bowen on the south and was traced with an approximate east-west strike and general southerly dip at gentle angles from Blue Hills to near Springsure.

South of the Middle Bowen Series and lying conformably on them we have the Upper Bowen consisting of basal limestones, overlain by coal measures with fine coal and kerosene shale seams, these again overlain by shales containing a rich flora of *Glossopterus* and *Gangamopterus angustifolia*, and then a sandstone formation (the Clematis Sandstone) which passes upwards into the basal micaceous sandstones of the Ipswich Formation. The top stages of the Upper Bowen, as well as the basal strata of the Ipswich, contain abundant stems of *Schizoneura*, *Neocalamites*, *Phyllothea* and other Equisetales, which seem to be also very abundant in the Tolmie-Clermont Coal Series, and are rather characteristic of the passage beds between the Permian and Triassic.

The Ipswich Series consists of the basal micaceous sandstones, over which we find a thickness of freshwater limestones with abundant *Schizoneura*, and then tuffs, shales and sandstones intercalated. The tuffs are often olive-green and the shales in part chocolate-coloured. They contain abundant remains of Equisetales and of *Thinnfeldia odontopteroides*. In the writer's opinion, this series is the equivalent of the Narrabeen Series in New South Wales.

Overlying the Ipswich Formation conformably, but commencing with a coarse conglomerate, we have the Bundamba Formation which is lithologically similar to the Hawkesbury Sandstone and is, in the writer's opinion, the equivalent in age of that well-known Sydney formation.

Above the Bundamba, and conformably resting on it, we have the Walloon Series, divisible to the north of Roma into a basal, felspathic sandstone, a highly calcareous freshwater formation, consisting of limestones, shales, calcareous sandstones, coals and kerosene shales, then a thick sandstone, then more calcareous sandstone, sandstone, felspathic shales and carbonaceous beds closely inter-laminated, forming the Orallo Coal Measures, then more shales and sandstones with minor inferior coal-seams to the top.

The Walloon Formations north of Roma have yielded no *Thinnfeldia*, and no large Taeniopteridae. *Cladophlebis australis*, *Taeniopteris spathulata*, *Otosamites Feistmanteli*, and *Sphenopteris superba* were the principal fossils found in the Walloon in this area, the only others being fragments of *Neocalamites* and other Equisetales, *Phloephyllum pecten*, *Dictyophyllum Davidi*, and seeds and spores.

The Walloon Formations are Jurassic and are the equivalents of the Upper Clarence, and of the formations met with by the writer west of the Nandewar and Warrumbungle Mts in New South Wales. Gilgai country like that in the

Narrabri corner of the Pilliga scrub, N S W, is one of the features of Lower Walloon physiography. Mound springs occur in the upper part of the Bundamba at Mt Hutton, Timor and Crystal Brook and are comparable with the Mound springs in the Pilliga Scrub, N S W. The plain country, commencing west of the Nandewar Mountains, is of the Queensland Walloon type and the Walloon Formations probably swing west through the northern edge of the Pilliga Scrub, then south-west through the western rim of the Pilliga Scrub, and thence south to Tundebine and Tenandra.

Overlying the Walloon conformably we have the Lower Cretaceous (Cretaceous marine), the basal beds of which are exceedingly rich in fossil wood, often *Teredo*-bored, mixed with marine shells. It is at the top of the marine series we get the first marked unconformity since the inception of the Lower Bowen.

On the Marine Cretaceous we have the Cretaceous-Tertiary (Desert Sandstone) lying unconformably and horizontally stratified.

The Cretaceous Marine Series is gently folded after the same manner as the Walloon as described in the Queensland Government Mining Journal, August, 1920, into gentle anticlines on the direction of general dip, and terraces on the direction of general strike.

3 *The Bowen Formations in the Type District* On a subsequent journey from Mt Coolon to Bowen, the writer noticed a strong development of dacites, felsites, rhyolites and porphyries, apparently of Upper Devonian age, at the head of the Sutor River, a tributary of the Bullockin. These volcanics are lithologically the equivalents of the Snowy River Porphyries and the Macedon dacites. In age they are probably Devonian.

The Bowen Formations in the type district lie in a synclinal basin having its centre near Havilah, the Lower Bowen Formations outcropping near the edge of the basin. The coal now being developed at the Bowen Coalfield is a *Glossopteria*-bearing freshwater series, overlying a series of boulder beds and conglomerates interbedded with sandstones and volcanics, and underlying the lower of the two marine formations described by Dr Jack in his Middle Bowen Series*. The marine limestones overlying the Bowen Coalfield (Collinsville coal measures) are lithologically and in general fossil assemblage very like the Dilly limestone (Lower Bowen) north of Springsure. The marine limestone at Pelican Creek (Bowen Coalfield) is immediately underlain by a glacial bed with faceted boulders and right in the marine limestones we have huge granite erratics carried by floating ice and dropped in the midst of delicate fossil organisms. Dr Jack in his original description of the field noticed these strong evidences of glacial action. The evidence of glaciation below, and within the marine limestones both at Dilly and Pelican Ck, confirms the belief that we are dealing with the same geological horizon and that *Eurydesma* will be found in the Pelican Ck limestone. This is also supported by the Carboniferous affinities of the fossils in each of the two localities. Thus the Pelican Ck limestone contains, *inter alia*, abundant *Productus cora*, *Productus subquadratus*, *Stenopora australis*, and *Protoretepora ampla* var. *woodsi*. Of these, all except *Productus cora* have also been recorded from Dilly near Springsure, and *Productus cora* has been recorded by Mr B. Dunstan, *inter alia*, from limestone lying west of Chine Bluff, Dawson.

* Preliminary Report on the Bowen Coal Field by R. L. Jack, 1879. See also Geology of Queensland by Jack and Etheridge.

Valley, a limestone formation which Mr Dunstan found continuous with "Gympie" limestone (see p. 8, Geology of the Dawson and Mackenzie Rivers, etc., Qland Geol Surv., Pub 155, 1901). These fossils serve to bring together the Lower Marine of Dilly, the Lower Marine of the Dawson-Mackenzie area and the Lower Marine of the type district and show that this marine series is Upper Kuttung or Lower Uralian and that the Bowen coal is a Carboniferous coal, lower than the Greta coal of New South Wales. The Bowen (Collinsville) coal is practically of an interglacial age.

In the type district the coal seams corresponding in position to those of the Greta of New South Wales, the Consuelo coal of the Carnarvons, the Bluff and Dawson coals in the Dawson-Mackenzie area, are apparently the "Dauntree" seam and also the associated series which lie above the Lower Marine. In the freshwater series between the Lower and Upper Marine horizons on the type field, *Glossopteris* and *Gangamopteris cyclopteroides* with *Sphenopteris*, *Cladophlebis Roulei* and *Phyllocladus* were very abundant.

4 *Glaciation and Folding* The period of maximum glaciation in Queensland, when the numerous thick boulder beds of the Lower Bowen were deposited, was the period of great movements of folding, and was a period immediately following an age of great granitic intrusions.

On palaeontological evidence we must regard the glacial period as Upper Carboniferous, and the last period of granitic intrusions in Palaeozoic times as Middle or Lower Carboniferous. This holds for the Carnarvons, Clermont, Mt Coolon, the Drummond Range and other parts of Central Queensland and is equally true for the Mackay-Bowen Districts and North Queensland generally. Thus in the Chillagoe-Herberton area the newer granites are later than the Devonian Hodgkinson Series, but earlier than the undisturbed Permo-Carboniferous Mulligan Series.

The principal period of intense folding and mineralisation in Queensland was the Lower to Middle Carboniferous, though the processes appear to have been a little later in South Queensland than in the north of the State.

5 *Absence of Glacial Evidence in the Middle and Upper Bowen Series* On the writer's many traverses across the Bowen strata in the Carnarvons he failed to see anywhere any sign of a glacial formation equivalent to the Braxton.

There was no evidence of any glaciation later than the Lower Bowen. Considerable importance must therefore be attached to the glacial series. They should be a more definite landmark in time than the evidence of more or less incomplete palaeontological collections.

Shell-banks vary in the content of living species in different places on any modern shore line. So they did in all ages. Until exhaustive palaeontological collections have been made, judgment passed on the age of beds on such fossil collections is likely to be weakly founded, especially in an area like the Bowen Coalfield where two marine series exist, and the fossils have in many cases become mixed and field-work has not yet definitely delineated which limestone the fossil locality belongs to. The Pelican Ck limestone has, however, been definitely determined to be the Lower Marine of the field as described by Dr Jack.

6 *Gangamopteris and Glossopteris of under range than supposed.* The Lower Bowen top limestone horizon being on the strength of glacial evidence probably the equivalent of the Dilly Springsure horizon, and the Dilly fossils being accompanied by *Eurydesmus* we see that the Bowen coals are Upper Car-

Table showing succession and relationship of geological formations in the country between Springsure and Roma, Queensland
(Additional table to face page 157, in *Proc Linn Soc N S W*, 1923, Part 2)

Formation	Approx thickness (in feet)	Other Equivalent Queensland Beds	Equivalent Formations in N S W	Type Fossils of Formation
Permian or Upper Bowen*	4 000	(a) Tuff and volcanic Boralion Bds Brisbane Valley (b) Clermont Coal Measures † Havilah and McArthur Coal Stams Bowen R	(a) Newcastle Stage, 1150 ft (b) Dempsey, 2,000 ft Tomago Coal Measures, 1 000 ft (c) Crinoidal Shales 2 600 ft	Crinoids, <i>Strophalosia clarkii</i> , <i>Productus brachythoeris</i> , <i>Zaphrentis Trachypora</i> , etc., in the marine beds and <i>Glossopteris</i> with <i>Gangamopteris angustifolia</i> and <i>Sphenopteris</i> in the freshwater beds
Middle Bowen (Lower Permian to Uralian)†	10 000	Mr B Dunstan's Lower Freshwater in the Dawson Mackenzie Valley Great Shale Series (freshwater beds with <i>Glossopteris</i> and <i>Gangamopteris</i> overlying Pelican Ck limestones Bowen field)	(a) Upper Marine, 3 400 ft (b) Greta Coal Measures, 300 ft (c) Ravensfield Sandstones	<i>Glossopteris</i> —several species, <i>Gangamopteris cyclopteroides</i> , <i>Sphenopteris delicatula</i> , <i>Cladophlebis Roylei</i>
Lower Bowen (Upper Carboniferous) Marine Limestones with erratics, boulder conglomerates, rhyolites and basalt-	7 000	Lower Marine in Dawson Mackenzie Valleys Lower Marine, Bowen Field Gympie in part	Lower Marine Brandon conglomerate (Uralian and Kuttung)	<i>Eurydesma cordatum</i> , <i>Productus subquadratus</i> , <i>P. cora</i> , <i>P. brachythoeris</i> , <i>Aviculopecten mitchelli</i> , <i>Rhombipora</i> , <i>Stenopora gymnaeus</i> , <i>S. australis</i> &c
Unconformity				
Star Beds (Middle and Lower Carboniferous)	13,000	Gympie and Star Beds (various districts)		<i>Lepidodendron Veltheimianum</i> , <i>Aneuropteris australis</i> , <i>Asterocalamites</i> , &c
(a) Upper beds with fish remains				
(b) Middle beds with plant remains				
(c) Lower Sandstones and basic lavas			Barundi Series	

*The Coal Measures of this period contain Torbanites both in N S W and Queensland
†In the Bowen field the Daintree team and other small seams occur in the shales between the Upper and Lower Limestones

^s Formation	Approx. Thickness (in feet)	Other Equivalent Queensland Beds	Equivalents N.S.W. formation.	Type Fossils of Series.
Cretaceous-Tertiary Unconformity.	?	Desert Sandstone.	Upper Cretaceous	none except petrified wood. Unios out west
Marine Cretaceous	2000 and over	*Rolling Downs Series, Maryborough Beds.	Marine Cretaceous	¹ <i>Maccoyella Barclayi</i> , <i>Fusulinula clarkii</i> , <i>Belonemites</i> , etc.
Walloon (Jurassic) Upper Walloon (with coal) Orallo Coal Measures Big Sandstone Calcareous (Injune Ck.) Basal Sandstone	500*	†Rosewood and Darling Downs	1. Upper Clarence Series 2. Artesian Series	<i>Cladophlebis australis</i> , <i>Tecmopteris spathulata</i> .
Bundamba (Upper Triassic)	3000- 5000	Bundamba Series (Ipswich Coal- Field)	1 Middle Clarence 2 Hawkesbury	
Ipswich (Lower Triassic) 1 Upper shales and tufts 2000 ft. 2 Lower micaceous sand- stones 2000 ft.	4000	Ipswich Coal Measures Callide Coal Measures ‡Esk-Biarra Series	1 Lower Clarence 2 Narrabeen	<i>Thamnielasma odontopteroides</i> , <i>Xenacalamites carreri</i> , <i>N. horensis</i> , <i>Egaseuthites</i> , <i>Schismoneura</i>

* The sandstones forming the artesian intake in North Queensland are Upper Walloon passing into Maryborough Beds (Croydon Beds)
 † The Marbury Beds of the Rosewood District seem to be equivalent of the basal sandstone, Injune District, and the Rosewood beds of the Calcareous (Injune Creek) Beds
 ‡ The Esk-Biarra Series may include the Bundamba in part

boniferous, and it follows that *Glossopteris* commences in the Carboniferous. It is equally interesting to note that *Gangamopteris cyclopteroides* is very abundant in the Middle Bowens and *G. angustifolia* in the Upper Bowens.

7 *Stratigraphical Sequence* The accompanying table has been constructed to show the stratigraphical sequence and thickness of the beds examined—the equivalents in other geologically examined parts of Queensland, the New South Wales equivalents and the type fossils.

8 *Afterword* It will be noticed that the Bowen Formations have been dealt with in this paper in the original sense, this being more in harmony with observed facts in the Carnarvon area than the classification of the Bowen Formations adopted by Mr Dunstan in his Dawson-Mackenzie report. Mr Dunstan varied from Dr Jack in speaking of a Lower Bowen consisting of Lower Marine, overlain by Lower Freshwater (Coal Measures), then Upper Marine and Upper Freshwater. This group of formations was bracketed as Lower Bowen and the Clermont-Tolmie Coal Measures were classed as Upper Bowen, the Middle Bowen of Dr Jack not being recognised.

The present writer has varied from Dr Jack's conception of the Bowens only in one particular. Finding that the Upper and Lower Marine limestones are only comparatively thin formations, the one lying between the Lower and Middle formation, the other between the Middle and Upper Bowen, it was deemed advisable to put the Lower Marine into the Lower Bowen Series where it also fits naturally on glacial evidence, and to put the Upper Marine into the Upper Bowen (Permian) where it fits well on account of the abundance of *Strophalosia*.

REVISION OF THE GENERA *ETHON*, *CISSEIS* AND THEIR ALLIES
(*BUPRESTIDAE*)

By H. J. CARTER, B.A., F.E.S.

(Twelve Text-figures.)

[Read 30th May, 1923]

The genera *Ethon* and *Cisseis* were first published by Castelnau and Gory in their famous "Monograph." Their diagnoses of these genera, together with the list of species, were so confused as to require considerable modification at the hands of later authors, e.g., these genera were distinguished, *inter alia*, by the alleged differences in the respective number of joints of the palpi, while of the eight species placed by them under *Ethon*, four, at least, are now referred to *Cisseis*. For a complete diagnosis of *Ethon* and of *Cisseis* see Kerremans (Genera Insectorum, 1902, pages 226 and 227).

Ethon is clearly differentiated from *Cisseis* by two characters in combination. (1) a strongly bilobed head, (2) the clearly longitudinal punctate elytra. The claws of their tarsi are long and bifid, somewhat as in *Neospades*, appearing as four equally long sharp spines. The posterior basal joints are, however, more elongate than in *Neospades*, the basal joint being the longest, while joints 2, 3 and 4 are of nearly equal length. The nomenclature has been complicated by misidentification and synonymy and the following table and notes on the species will, it is hoped, simplify the study by our future workers.

Both *Ethon* and *Cisseis* occur on flowers of many species. I have taken *E. corpulentum* and *E. affinis* chiefly on *Dillwynia*, *Pultenea* and *Leptospermum* in the Sydney region.

Froggatt (Australian Insects, p. 165) states that "*E. affinis* forms galls upon the stems of *Pultenea stipularis*," while *E. corpulentum* and *E. marmoreum* (? *Cisseis acuducta* Kirby) "make rounded galls upon the roots of *Dillwynia ericifolia*, sometimes as many as 20 on one plant, clustering round the base of the stem."

	No of names investigated	No of species considered valid	No of new species added
1 <i>Ethon</i>	12	5	1
2 <i>Cisseis</i>	36	38	7
3 <i>Neospades</i>	17	10	--
4 <i>Hypocisseis</i>	13	5	2
5 <i>Alcinous</i>	2	1	--
Total	130	59	10

Thus after rejecting names that are either preoccupied, synonyms, or *nomen nudum*, 130 names are reduced to 59, while 10 new species are here recorded. Future investigation may suggest some modification of this treatment, but at least clearer identification of existing species and their correct nomenclature is now possible.

Table of species of Ethon

1	6	Colour bronze or coppery with pubescent fascicles	
2	4	Form oblong oval, underside subglabrous	
3		Surface nitid, elytral punctures scratch-like	<i>affine</i> C. & G
4		Surface duller, elytral punctures coarser	<i>roei</i> Saund
5		Form sub-conical and convex, underside strongly pilose	<i>corpulentum</i> Boh
6		Form shortly ovate, underside subglabrous	<i>breve</i> , n sp
7		Colour opaque violet, form elongate-conic, striation of elytra sub-continuous	<i>maculatum</i> Blkb
8		Colour bronze-green without fascicles	<i>fasciceps</i> Kirby

Synonymy (a) *affine* C & G. = *aurifluum* Hope = *purpurascens* Hope = *proxima* Boh = *reicher* Chev

(b) *fasciceps* Kirby, (?) Boisd = *viride* C & G. = *diversum* Kerr

(c) *corpulentum* Boh = *fasciceps* C & G (*neo* Kirby)

(d) *roei* Saund. = *subfasciatum* Saund

I have seen the types of all except *proxima*, *viride* and *corpulentum*. It is quite evident that *fasciceps* was wrongly determined in the Monograph of Castelnau and Gory, and equally evident that the figure given by them as *fasciceps* is that of *corpulentum* Boh, having the distinguishing oblique fasciation at the apex.

(b) obviously identical

(d) I think *subfasciatum* is the male of *roei*—the types being respectively ♂ and ♀ of the common species from Western Australia, variable in size, and the pubescence readily abraded—as in the type of *roei*—which is almost uniform bronze with a duller surface than in *affine*.

The species *corpulentum* Boh. and *affine* C & G are common on the flowers of *Dillwynia*, near Sydney, in September and October. The former is easily separated (i) by its strongly pilose underside, (ii) by apical markings; a sub-apical zig-zag fascia, and behind this, two obliquely outwardly directed markings. *E. affine* has a wide distribution through Eastern and South-East Australia. *E. maculatum* Blackb, type in British Museum, measures $9\frac{1}{2} \times 4$ mm., though given as $3\frac{3}{5}$ - $4\frac{2}{5}$ lines. This apparently is found in New South Wales and Queensland as well as in South Australia, from examples I find in collections, and is recognised by the combination of conical form, dingy, vaguely-spotted, violaceous upper surface—the pubescent fascicles being distributed more or less over the whole elytra—with nitid, subglabrous underside. *E. scabiosum* Boisd, misspelt *scabiorum* in Castelnau and Gory's Monograph, is quite unknown to me—though probably a *Cisseis*, if the figure of the "Monograph" be correct.

The following species is undescribed

ETHON BREVE, n sp (Text-fig 1)

Shortly ovate, convex. Head, prothorax and abdomen coppery, elytra purple-violet with three undefined fascicles on apical half and sub-obsolete fascicles on basal half; underside nitid and feebly tomentose, sides of abdomen albo-squamose.

Head strongly bilobed



Prothorax short, strongly widened from apex to base, anterior angles obtusely rounded, posterior acute, base strongly sinuate, the medial lobe widely oval, surface more finely sculptured than in *E. roei* Saund. or *maculatum* Blkb. with little transverse sculpture. *Scutellum* large, triangular and smooth. *Elytra* widest near base, thence arcuately narrowed to apex, seriate-punctate, the punctures linear, less elongate than in *maculatum* Blkb., narrower than in *roei*.

Text-fig 1. Saund. Underside finely, closely punctate. Dim 6.7 x 3.3 mm

Hab.—Western Australia Perth (J Clark, and Brit Mus), Wyndham (J Clark)

A species I cannot reconcile with described species—through its shorter oval form, nitid underside, the short prothorax—strongly narrowed in front. Types in Coll. Carter. The sexes taken in cop by Mr. Clark.

Var. (f).—Three examples taken by Mr. A. H. Elston at Mt. Lofty, near Adelaide (S.A.), have the head and pronotum dull coppery bronze, the elytra purple-bronze, and are more elongate-ovate (narrower) than the Western forms 6.7 x 2.4–3 (vix) mm. These have the fine sculpture of *breve*, but may prove to be a distinct species.

CISSEIS Castelnau et Gory.

Six species were originally named in the Monograph of the above authors, namely, *duodecim-guttata* Guér., *albosparsa* C. & G., *stigmata* C. & G., *irrorata* Hope, *marmorata* C. & G., and *cupripennis* Guér., while, as noted above, at least four of the species included under *Eithon* belong to *Cisseis*. These are *leucostictum* Kirby, *bicolor* C. & G., *marmoratum* C. & G. and *maculatum* C. & G. *West-woods* was described as a *Coraebeus*. This list omitted *cruciata* F. (for which see *Neospades*), *duodecim-maculata* F. and *acducta* Kirby. *Duodecim-guttata* Guér. (also Boisd.) is the well known *12-maculata* F., of which I have examined the type in the British Museum. *Albosparsa* C. & G. is familiar as a widely distributed Queensland species.

Stigmata C. & G. is a well known Western Australian species.

irrorata Hope was incorrectly determined by Castelnau and Gory, and is the species described by these authors as *marmorata*, and by Saunders as *similis*, while *irrorata* C. & G. is, I consider, the same as *maculata* C. & G. I have seen the types of Hope and Saunders. The species is well known from New South Wales and Victoria (see *infra*).

Cupripennis Guér. (also Boisd.), described from Port Jackson, is a common species in South-Eastern Australia, and generally well known in Museums.

Leucosticta Kirby is widely distributed over the greater part of Australia, associated with *Acacia* foliage. As in all common species, there is great variation in size and colour. The type measures 14 x 5 mm, has a brassy pronotum and green underside, but green often replaces the brass of the prothorax and head, while I have examples from Geraldton, W.A., in which the thorax and underside are bronze (not coppery). *C. aurulenta* Kerr is doubtfully distinct from this.

Bicolor C. & G. is readily determined in a widely oval species well known from Western Australia, but which I have taken rarely in New South Wales,

* *Eithon brevis*, n. sp.

and occurs in Victoria and South Australia. It varies in size from 8 to 14 mm long, while a dwarf in the British Museum Coll. is only 5 mm long.

Marmorea C & G is the species better known as *acuduota* Kirby, which has many synonyms and a wide distribution, probably the commonest species in Eastern Australia. Kerremans erroneously placed *marmorata* C & G under *acuduota* in the Genera Insectorum, instead of *marmorea*.

Maculata C & G is a small, narrow species, common, especially in Victoria and Tasmania, on *Lepidospermum*. The white pubescence is readily rubbed from this otherwise bronze species, so that it rarely appears as in the figure of the Monograph, except as to the four apical spots (if Kerremans' identification and my own are correct). I have not seen the type.

In 1832 Hope redescribed *12-maculata* F. under the name *canthosticta*. In 1836 he published *irrorata*, *lata* and *aenea* (of which the last two = *acuduota* Kirby). In 1845 he added *roseocuprea*, *signaticollis*, *gouldii*, *cupreicollis* (with its female form *aeneicollis*), besides again repeating *12-maculata* as *14-notata*. Thus of 10 species, only 4 are to-day valid. I have examined all his types.

In 1848 Germar described four species, *notulata*, *chrysopygia*, *nubeculosa* and *chalcoptera*. Of these, the first has been identified by Blackburn—whose authority as a long resident in the Adelaide District, and as a keen and able entomologist, carries weight—and I have followed him in this. The species is widely distributed throughout South Australia, Victoria and New South Wales.

For *chrysopygia*, see under *Neospades*.

Nubeculosa and *chalcoptera* are the respective female and male of the same species, the thorax of the male being metallic green, that of the female bronze. Analogous sexual colouration occurs at least in *cupripennis* Bois, *marmorata* C & G and, probably, in other species.

In 1868 Saunders described *similis* and *suturalis*. The latter is referred below to *Hypocissus*, the former sunk as a synonym.

Macleay (1872 and 1888) described eight species, of which *latipennis* is a *Hypocissus*, *dimidiata*, *apicalis* and *purpureotincta* are forms of the varicoloured *chrysopygia* Germ., *impressicollis* and *nigripennis* are, I think, synonyms of *roseocuprea* Hope and *Neospades simplex* Blackb. respectively, thus leaving only two valid species, *viridaurea* and *fulgidicollis*, of which the former is a *Neospades*.

In 1876 Gestro described (Ann. Mus. Gen., viii) two species *albertus* and *cuprifera* from Cape York (omitted by Kerremans from Gen. Ins.), the former of these is almost certainly synonymous with *albo-sparsa* C & G, the latter is a *Neospades* of unusual beauty that occurs in Northern and North-West Australia.

In 1879 Thomson published descriptions of thirteen species, of which seven are probably valid. I have not, however, seen his types.

Regalis is, I think, an elongate species near *leucosticta* Kirby and *fulgidicollis* Mael., much less convex than the former, with a more sparse puncturation—the elytra violet-purple with irregular white pubescent spots. In Macleay's species, the form is generally less elongate and wider, with the pubescent spots definite in number and position. *Opima*, *rugiceps*, *subcarinifrons*, *uniformis* and *minutissima* will be found in my tabulation and notes subjoined to this. *Atro-violacea*, as determined by Kerremans, varies from the description of that species in smaller size. *Semiscabrosa*, I have not been able to identify—it is probably one of the many forms of *Neospades chrysopygia* Germ. *Viridicollis* is, I consider, the male of *marmorata* C & G, but I have no decisive field evidence of this. The remaining four are obvious synonyms (see below).

Between 1887-1891 Blackburn described 13 species, including *Neospades simplex* and *N. lateralis*, besides *Hypocissus* (*Corabus*) *pilosicollis*. Of Blackburn's species, *bella* is probably only a form of *N. simplex*, *dispar* = *roseocuprea* Hope, *verna* = *westwoodi* C & G while *constricta* and *linda* are, I think, the respective sexes of the same species. This leaves nine valid species.

In 1898 and 1902 Kerremans described one *Ethon* and 41 species of *Cissus* from Australia (including two species of *Neospades*). I have seen all his types. *E. diversum* is an obvious synonym of *E. fusciceps* Kirby, of which the type is also in the British Museum. Of the 41 species, I can only recognise 12 as distinct from previously described species. These are *scabrosula*, *aurulenta*, *nitidicollis*, *viridiceps*, *vicina*, *collaris*, *cyanura*, *negro-aenea*, *viridis*, *fossicollis*, *rubicunda* and *puella*, of which *aurulenta* is doubtfully separable from *leucosticta* Kirby, *collaris* is doubtfully distinct from *vicina*, while *negroaenea* and *viridis* are referred to *Neospades*. The synonymy of the remaining 29 species is stated below. Many of the types are unique—often mere variations from small species that are difficult of distinction.

One other Australian *Cissus* has been described by Théry as *C. terrae-reginae*. A specimen so labelled by Dr Obenberger has been sent me, and corresponds to the description. It is a *Neospades* very near to, but distinguished from, *N. viridaurea* Mael. (See tabulation below).

Buprestis lapidosa W S Mael.—This species is wrongly placed amongst *Cissus* in the Genera Insectorum, and other catalogues. The type is in the Macleay Museum, Sydney. It cannot be referred to any existing Australian genus, and is probably a misplaced exotic or, as in the case of *B. aurulenta* F., a species bred in Australia from imported timber. Writing from memory in London, it is near the American genus *Dicercia*.

The following tables will show my present view of the Genera *Ethon*, *Cissus*, *Neospades*, *Hypocissus* and *Alcinous*.

The following tabulation, it is hoped, will help to determine the species.

CISSUS Sect. 1

Elytra clearly impressed with white pubescent spots

- | | | | |
|----|----|---|---------------------------|
| 1 | 6 | Ground colour of elytra dark blue | |
| 2 | 4 | Pronotum blue, with pubescent vitta above lateral carina | |
| 3 | | Disc without foveate impressions (8.10 x 4 mm) | <i>12-maculata</i> F |
| 4 | | Disc with two foveate impressions (5.7 x 2.2½ mm) | <i>elongatula</i> Blkb |
| 5 | 7 | Pronotum coppery or brassy green, disc with pubescent foveate impressions | |
| 6 | | Pronotum (except on foveae) and underside glabrous | <i>stigmata</i> C & G |
| 7 | | Pronotum with inter-carinal space also sides of abdomen pubescent | |
| | | | <i>signaticollis</i> Hope |
| 8 | | Pronotum coppery (♂) or bluish (♀) without pubescence, size small (5.7 mm l) | <i>cupreicollis</i> Hope |
| 9 | 16 | Ground colour of elytra purple—sometimes blue (In this case distinguished from preceding by the coarsely punctate pronotum) | |
| 10 | 12 | Elytral spots indefinite in number, irregularly spaced | |
| 11 | | Form robust and convex—pronotum densely and coarsely punctate | |
| | | | <i>leucosticta</i> Kirby |
| 12 | | Form subdepressed, narrower than 11, pronotum sparsely punctate | |
| | | | <i>regalis</i> Thoms |
| 13 | 15 | Elytral spots definite in number, eight arranged in a circle | |
| 14 | | Form elongate, disc of pronotum subsparingly punctate | <i>fulgidicollis</i> Mael |
| 15 | | Form widely ovate, pronotum finely rugose-punctate | <i>bicolor</i> C & G |
| 16 | 18 | Upper surface golden (pronotum sometimes green in <i>aurulenta</i>) | |

- 17 Elytra multi-maculate *aurulenta* Kerr.
 18 Elytra with eight spots, definitely arranged *albo-sparsa* C & G
 19 Pronotum fiery copper elytra brownish, the spots less defined than in 18
inflammata, n.sp

C. aurulenta Kerr is possibly a small var. of *leucosticta* Kirby, a very variable species, widely distributed throughout Australia.

In the Monograph of Cast et Gory, the figure of *albosparsa* shows only six spots. Fresh examples, however, show eight.

NB—The very distinct species 11, 12 and 14 (*supra*) are much confused in collections.

C. cupreicollis Hope, is extremely like *Neospades simplex* Blkb., but has quite different tarsal claws, besides being shorter and less cylindric in form.

C. elongatula Blackb.—The type of this, in the South Australian Museum, is a badly abraded example that makes identification difficult. There are, however, so few Cisseis that combine the pubescent lateral vitta of pronotum with spotted elytra, that I consider three fresh examples in the same collection as conspecific. In these the elytra are clearly blue, with the spots arranged very much as in *12-maculata*, showing also (in two examples) smaller, scattered, pubescent spots.

Synonymy

(a) *duodecemmaculata* F. = *12-guttata* Boisd. = *14-notata* Hope = *xanthosticta* Hope = *pustulata* Thoms.

(b) *leucosticta* Kirby = *stellulata* Dalm. = *fulgidifrons* Kerr.

(c) *cupreicollis* Hope = *aeneicollis* Hope (♂) = *morosa* Kerr.

(d) *albosparsa* C & G = *albertus* Gestro = *cupriventris* Kerr.

(a) Occurs from East to West of the Continent, breeding in, and found on leaves of *Xanthorrhoea* plants.

(b) is perhaps the most widely distributed Cisseis in Australia, found in every state on *Acacia* foliage, I have examples from Geraldton, W.A., in which the pronotum and underside are bronze (not coppery), with the upper surface more coarsely punctured than usual. The type of *fulgidifrons* is only a small male of typical form and colour.

(c) The type of *morosa*, is an abraded and discoloured *cupreicollis* Hope (var. *aeneicollis* Hope).

CISSEIS Sect. II

Elytra vaguely impressed with white pubescence.

Group A. Pubescence, in fresh examples, forming more or less circular spots.

- | | | | |
|---|---|--|-------------------------|
| 1 | 4 | Size large (10-13 mm), pronotum and underside sexually coloured (♂ green or bronze ♀ more or less concolorous, with elytra rarely green) | |
| 2 | | Form parallel, elongate—bronze or bronze green | <i>marmorata</i> C & G. |
| 3 | | Form widely oval, sides of pronotum well rounded, colour purple, or purple bronze | <i>nubeculosa</i> Germ. |
| 4 | | Form as in 3 but more acuminate behind, sides of pronotum nearly straight on basal half—colour dark bronze | <i>opima</i> Thoms. |
| 5 | 9 | Form elongate-ovate—subparallel | |
| 6 | | Size medium (8-9 mm), head usually bilobed, pronotum, base and apex of elytra bright purple, rest of elytra violaceous | <i>rugiceps</i> Thoms. |
| 7 | | Size small (5½-7 mm) Pronotum and underside coppery bronze, elytra brilliant purple or violet | <i>tyrrhena</i> , n.sp. |

8 More or less concolorous, bronze, spots, except apical 4, very vague

9 Pronotum brassy, or coppery green, elytra blue-black . *maculata* C & G
viridicollis Kerr

Notes on the above—*C. marmorata* C & G is the large well-known species not uncommon in New South Wales and Victoria, of which the male is narrower and with metallic green or bronze pronotum and underside, described as *viridicollis* Thoms, and of which I have elsewhere described a bright green variety. The pubescence is often abraded—and obscure as in all the above.

Nubeculosa Germ is the female, *chalcoptera* Germ the male of the same species—as recorded by Blackburn. The male is not unlike, when the pubescence is absent, a large sized *cupripennis* Boisdu. It is common in South Australia and Western Victoria.

Opima Thoms is more triangular and of darker colour than *nubeculosa*, with a very differently shaped pronotum, wide but straight-sided behind, roundly narrowed in front. The males are similar in form but smaller. This species, apparently, only occurs in Western Australia.

Rugiceps Thoms is noteworthy for its strongly excavate head, which, together with the pronotum, is unusually strongly sculptured—the sculpturing of the pronotum consisting chiefly of undulate transverse ridges. The purple colour carried over to the base of elytra is noteworthy, as also the same colour on apex, together with its green abdomen.

C. maculata C & G—I have accepted the determination of Tasmanian examples in the British Museum for this species, of which I have been unable to find the type, the pubescence is generally very vague, except as to the apical four spots. It is also the species described by Kerremans as *tasmanica*, indistinguishable from *pauperula* Kerr (per type).

C. viridicollis Kerr is very like *ignicollis* Kerr (= *Neospades simplex* Blkb.), but the pronotum is much wider, and the claws those of *Cissus*.

Synonymy—(a) *marmorata* C & G = *similis* Saund = *irrorata* Hope (nec C & G) = *viridicollis* Thoms = *aenea* Kerr

(b) *nubeculosa* Germ = *chalcoptera* Germ

(c) *maculata* C & G = *tasmanica* Kerr = *pauperula* Kerr

Group B Pubescence, in fresh examples, not in spots, more or less marbled

1 26 Head not or very feebly excavate between eyes

2 4 Size large (12-14 mm long)

3 Elongate obovate, prothorax wider than base of elytra *laticollis*, n.sp.

4 Ovate elliptic, prothorax narrower than base of elytra *elliptica*, n.sp.

5 9 Size smaller, (10 mm long or less)

6 Whole surface green, elytra coppery green form like *opima* *ovalis*, n.sp.

7 9 Upper surface more or less bronze

8 Rather widely oval, elytra nitid (8-10 mm long) *acuducta* Kirby

9 Narrowly oval, elytra with opaque subcyaneous patch (6-7 mm l) *soabronula* Kerr

10 12 Size small (4-5 mm long)

11 Prothorax narrowing to apex, lateral carina not evident from above tinged cyaneous *parva* Blackb.

12 Prothorax normally arcuate, lateral carina evident from above *viridiceps* Kerr

13 22 Pronotum and elytra differently coloured, the former more or less brilliantly metallic

- 14 Form oval, pronotum golden copper, elytra amethyst blue *pulchella*, n sp
 15 25 Form narrowly ovate
 16 18 Elytra blue black
 17 Pronotum bright bronze *atrovioacea* Kerr (? Thoms)
 18 Pronotum metallic green *vicina* Kerr, ? *collaris* Kerr
 19 Elytra violaceous, pronotum igneous purple, this colour more or less invading basal part of elytra *notulata* Germ, ? *violacea* Kerr, ? *nigrita* Kerr
 20 22 Elytra purple pronotum bronze or coppery
 21 Pubescence in scattered patches over whole elytra *obscura* Blackb
 22 Pubescence confined to apical areas *rubicunda* Kerr
 23 25 Upper surface metallic green
 24 Pronotum with large, deep fovea on each side *fossicollis* Kerr
 25 Pronotum without such foveae *westwoodi* C & G
 26 Form cylindric, upper surface blue-black *cyanura* Kerr
 27 Head strongly excavated between eyes, pubescence scattered over whole elytra *pygmaea* Blackb
 28 Smaller and more parallel than preceding *puella* Kerr

Semi-scabrosa Thoms has been omitted from the above as unknown to me
 It is possibly a variety of *chrysopygia* Germ

The species, especially the smaller ones (the greater number), of this section are very difficult to separate. Little is known of their sexual relation, and there is often a strong sexual colouration in the genus, while old, badly abraded or stained examples often present a widely different appearance from fresh examples. Where more than one name appears under a number in the above tabulation it does not necessarily imply synonymy—but that the species are so close as to prohibit their clear tabulation by definite characters.

Synonymy—(a) *acuducta* Kirby = *marmorea* C & G = *lata* Hope = *aenea* Hope = *cuprifrons* Kerr = *laeta* Kerr

(b) *collaris* Kerr = *ornata* Kerr

The types are identical—*vicina* is doubtfully separated from these by its larger size, but an examination of a longer series is necessary.

(c) *notulata* Germ—Adopting Blackburn's determination of this South Australian species I consider that *inops* Kerr and *semiobscura* Kerr are identical with Germar's species, while *violacea* can only be distinguished by the fact that the elytra are wholly violet—whereas in the other three the basal area is more or less bright purple. *Nigrita* is, I think, but a dark form of the preceding. Thus *notulata* Germ = *inops* Kerr = *semiobscura* Kerr = ? *violacea* Kerr = ? *nigrita* Kerr

(d) *obscura* Blackb = *undulata* Kerr. = *purpurea* Kerr

(e) *rubicunda* Kerr = *modesta* Kerr

Only slight colour difference separates the types. A western species

(f) *parva* Blackb = *simplex* Kerr

(g) *viridiceps* Kerr = *oblonga* Kerr

(h) *westwoodi* C & G = *verna* Blackb = *viridana* Kerr = *théryst* Kerr

Occurs in Victoria, Tasmania and South Australia.

(i) *puella* Kerr = *curta* Kerr. I am doubtful as to the identity of this with *pygmaea* Blackb. Both have the *Ethon*-like head, and both occur in New South Wales, but *puella* is smaller and more parallel than *pygmaea*, while the less amount of pubescence on Kerremans' type may be accounted for by abrasion.

CISSEIS Sect III

Elytra without pubescent impressions

- | | | | |
|----|----|---|--|
| 1 | 3 | Forehead with a medial carina | |
| 2 | | Pronotum bronze, elytra violaceous, apex and apical margins coppery (8.9 mm long) | <i>careniceps</i> , n.sp |
| 3 | | Upper surface purple or coppery bronze, margins of pronotum tinged green (5.7 mm long) | <i>subcarens</i> Thoms, ? <i>occidentalis</i> Blkb |
| 4 | 12 | Forehead without carina | |
| 5 | 7 | Upper surface dark | |
| 6 | | Pronotum abruptly constricted at base, elytra purple bronze, margins coppery | <i>constricta</i> Blkb |
| 7 | | Sides of pronotum nearly straight | <i>perplexa</i> Blkb |
| 8 | 12 | Upper surface brilliant metallic | |
| 9 | 11 | Sides of pronotum lightly rounded | |
| 10 | | Whole surface coppery bronze (6.7 mm l) | <i>roseo-cuprea</i> Hope |
| 11 | | Whole surface green, or bronze-green (3.4 mm l) | <i>minutissima</i> Thoms |
| 12 | | Sides of pronotum obliquely narrowed from base to apex, colour uniform green (5.6 mm l) | <i>uniformis</i> Thoms |

Synonymy—(a) *subcarens* Thoms = *cincta* Kerr = (?) var *occidentalis* Blkb

Thomson's description corresponds with many examples from King George's Sound, that are certainly *cincta* Kerr (The type of *occidentalis* is unique, I have been unable to match it. Smaller than Thomson's species, 5 mm instead of 7 mm, it is also of brighter colour, with a slight difference in the form of the lateral carina but I think these are conspecific)

(b) *constricta* Blkb = *hinda* Blkb. The former is the male, the latter the female, of the same species. Both forms occur in the British Museum Coll from N.W. Aust., the male, as is frequent in the genus, having a bright metallic pronotum and head.

(c) *roseocuprea* Hope = *impressicollis* MacL = *dispar* Blkb = *cuprea* Kerr = *fairmairei* Kerr

I have seen the types of all of these and find the first four identical. The last is, I consider, a variety in which the head and pronotum are greenish, the sides of the latter slightly wider than usual. A common species in Victoria and South Australia.

(d) *uniformis* Thoms = *coraeboides* Kerr. The dimensions were omitted in Thomson's casual description, but I have little doubt as to their identity. The examples examined are from Victoria and Tasmania.

Perplexa Blkb has the claws of a typical *Cisseis* though like *Neospades nigroaenea* Kerr in size and form. The colour of the elytra is quite different, being dark violet, while the punctures on both pronotum and elytra are much more lightly impressed than in *nigroaenea*. This is a Western species.

C. minutissima Thoms—I have several examples that correspond with Thomson's description of this species from Perth (J. Clark) and Pinjarra, W.A. (A. M. Lea). It was described as from South Australia.

CISSEIS INFLAMMATA, n sp (Text-fig 2)

Elongate ovate, head (of ♂) green, (of ♀) fiery copper, pronotum, scutellum, underside and antennae fiery red copper, elytra brownish copper with green or blue tints near base, ruddy copper near apex, with some vaguely defined spots smaller than, but placed as, in *albo-sparsa* C & G.

Head nearly flat, with feeble longitudinal impression, strongly, not densely, punctate

Prothorax Apex nearly straight, base lightly bisinuate, sides (seen from above) obliquely narrowed from base to apex—the lateral margin (limited by lower carina) rather widely rounded in a vertical plane, anterior angles obtuse, hind acute, upper carina not nearly extending to apex, disc without a sign of medial line, sparsely and finely punctate in middle, becoming transverse laterally

Scutellum large, nitid and transverse, triangularly extended behind *Elytra* widened at shoulder, rather strongly narrowed at apex, apices separately rounded and comparatively coarsely serrate, disc more distinctly punctate than usual, punctures large on basal half, fine and close near apex—the eight pubescent spots vaguely marked (in one example six spots only can be discovered) *Dim* 8.9 x 2½–3 mm

Hab—Queensland Johnstone River (H W Brown), Endeavour River (Melbourne Mus), Cairns (Coll Lea)

Six examples, three of each sex, examined It is nearest *albo-sparsa* C & G and *tyrrhena*, n sp but unlike either The coppery pronotum and underside are as in *Melobasis pyritosa* Hope The colour of the elytra is elusive and variable with the light on it, that of the male type being suffused with blue

Types in Coll Carter

CISSEIS MARMORATA C & G var *PRASINA*, n var

Two examples (male) in the British Museum and two in the South Australian Museum (Blackburn Coll) are structurally so close to *similis* Saund that I consider them colour varieties of that species, of which the males, as in many others, have the head, thorax and underside green or bronze-green In those under notice the whole surface is metallic green, in one example peacock blue-green *Dim* 14.16 x 3½ mm

Hab—N S Wales (Saunders Coll Brit Mus)

C. viridicollis Thoms has been already noted as probably the male of *marmorata* C & G

CISSEIS TYRRHENA, n sp (Text-fig. 3)

Elongate ovate *Head*, pronotum, underside and appendages coppery bronze (head sometimes green) elytra brilliant purple or violet, with six not very clearly defined spots in a circular formation (as in *albo-sparsa* C & G), i.e., two near apex, two near sides, and two near suture near middle of elytra

Head canaliculate and depressed in middle, finely and densely punctate

Prothorax Apex and base bisinuate, sides arcuately narrowed to apex, anterior angle obtuse, posterior subrectangular, upper carina not extending to apex, subconcentrically punctate, with a foveate impression on each side near base *Scutellum* transversely oval *Elytra* rather narrowly oblong, covered with scale-like punctures, apices finely rounded, minutely serrulate. *Sternum* coarsely, abdomen very finely punctate, the segments of latter with alhopubescent spots at sides (in fresh examples) *Dim* 5.5–7 x 2.3 mm

Hab—N.W. Australia (DuRoiulay and Saunders Coll Brit. Mus.), Kalamunda (H M Giles), Bunbury and Perth (J Clark), Pinjarra (A. M. Lea)

Many examples show a distinct species of narrowly oblong form, and of brilliant colours, somewhat suggesting *nitida* Kerr The elytral pubescent spots

can just be made out in some cases. Variations without the pubescent spots, sometimes with more obscure pronotum are in the British Museum, labelled Albany. The broader examples, where examined, are female and these in general show the maculae more clearly. Type in Coll. Carter.

Cissalis laticollis, n.sp. (Text-fig 4)

Elongate, oblong-obovate, subopaque bronze-violet above, pygidium tinged cyanaceous, elytra with a vague, pubescent, fasciate impression near apex, and some pubescence near middle and sides, underside dull coppery bronze, often with a violet or bluish tinge—legs and tarsi following the colour of underside—antennae bronze.

Head coarsely punctate, sparsely pubescent with a large, oval medial impression.

Prothorax Apex arcuate, base strongly bisinuate, sides very widely rounded, greatest width in front of middle, apex as wide as base, anterior angles (from above) acute, posterior obtuse, the two lateral carinae widely separated, sinuately



Text-fig 2 *Cissalis inflammata*, n.sp. Text-fig 3 *C. tyrrhena*, n.sp. Text-fig 4
C. laticollis, n.sp. Text-fig 5 *C. elliptica*, n.sp. Text-fig 6 *C. ovata*, n.sp.
 Text-fig 7 *C. pulchella*, n.sp. Text-fig 8 *C. carenceps*, n.sp.

parallel till near base, a large fovea near apex, surface closely and finely, transversely rugose except a wide, nearly smooth, medial space, fresh examples with a fine grey pubescence scattered over greater part. *Scutellum* very transverse. *Elytra* wider than prothorax at base and three and a third times as long, compressed near middle, enlarged behind, apices widely and minutely serrulate, these not covering pygidium and coarsely punctate, disc covered with scale-like punctures (much closer than in *similis* Saund.) these coarser towards apex, underside minutely punctate, with a sparse short pubescence. *Dim* 11-14 x 4-5 mm.

Hab—Queensland: Wide Bay (British and Australian Mus.), Brisbane (Queensland and S. Aust. Mus.).

A curious, irregular elongate species that can only be confused with *similis* Saund., from which it is clearly separated as follows

<i>C similis</i>	<i>C latiscollis</i>
<i>Prothorax</i> widest behind middle, sides lightly rounded	widest before middle, sides strongly rounded
<i>Elytra</i> nitid, oblong-ovate	sub-opaque, oblong obovate

Type in British Museum

A male example in the Queensland Museum is much smaller (9 x 3.3 mm) and has the head, pronotum and underside green or bronze green

Var CYANEOPYGA, n var

Two examples from Western Australia (Lake Austin—H. W. Brown, in Coll. Carter) and British Museum, differ from the typical *latiscollis* in having the *prothorax* widest at middle, the *elytra* less widened behind, the pygidium bright blue, or blue-green. In the British Museum example the pronotum is also suffused with blue-green. This may prove, with the study of further material, to be distinct.

CISSEIS ELLIPTICA, n sp (Text-fig 5)

Elongate elliptic, bronze or violet bronze, moderately nitid. The pronotal depressions pubescent as well as irregular pubescence on *elytra*, underside strongly pubescent, abdomen (in fresh examples) covered with white flocculence.

Head rather flat, finely channelled and pubescent, vertex coarsely punctate.

Prothorax Apex moderately, base strongly bisinuate, sides nearly straight, obliquely widening from apex to base, lateral carinae not parallel, the upper more sinuous than lower and continuous to apex, the lower unseen from above, all angles acute, the posterior wider, disc with two longitudinal depressions, one interrupted, irregular and wide on each side of middle, the other narrower inside apparent margin, finely sparsely punctate at middle, coarsely and transversely rugose towards sides. *Scutellum* transversely oval, punctate. *Elytra* lightly enlarged at shoulders, elliptically narrowed behind, apices separately rounded, hind margins strongly serrated, surface covered with scaly punctures, somewhat as in *similis* Saund., but becoming denser and finer towards apex, near base some longitudinal depressions continuous with those on pronotum. Underside, where not obscured by pubescence, coarsely punctate. *Dim* 14 x 5 mm.

Hab—Western Australia: Cue and Tenindewa (H. W. Brown).

Two examples given me by their captor are abundantly distinct from *latiscollis* and *similis* by their convex elliptic form, oblique straight-sided *prothorax* with its unusually defined hind angles. Types in Coll. Carter.

Var FRONTALIS

Two examples (the sexes) from N. Queensland (Kuranda—Dodd in Coll. Carter, and Herberton—Queensland Mus.) differ in having the head arcuately depressed between eyes, the sides of the arch raised above the level of the eyes and the underside nitid, lightly pilose, without flocculence.

CISSEIS OVALIS, n sp (Text-fig 6)

Widely oval, head, pronotum, underside and legs green, *elytra* coppery green, vaguely impressed near apex, antennae and tarsi blue.

Head arcuately impressed in middle, coarsely punctate.

Prothorax Apex and base bisinuate, the latter with medial lobe very wide, sides subparallel on basal half, thence arcuately narrowed to apex, space between lateral carinae oval, upper carina not continuous to apex, two wide impressions near base, disc moderately convex, rather densely, subconcentrically rugose-punctate. *Scutellum* transversely oval. *Elytra* oval, apices widely,

scarcely separately rounded, margins near apex finely serrate, almost uniformly scalose punctate, a few vague, sub-pubescent impressions near sides and apex, underside very nitid and densely punctate, sides of abdomen with pubescent impressions. *Dim* 9 x 4 (vix) mm

Hab—Western Australia (Du Boulay in British Museum)

A single example, probably male, is quite unlike any of the described metallic green species. In shape near *opima* Thoms, in colour unlike any—though in this as also in elytral sculpture it is near *roseo-cuprea* Hope. Type in British Museum

CISSEIS PULCHELLA, n sp. (Text-fig 7)

Oval. Head green or golden, pronotum and scutellum brilliant golden copper, elytra amethyst blue, with subfasciate white pubescence near apex, underside green, tinged with blue, sides of abdomen apparently non-pubescent, legs, tarsi and greater part of antennae blue, basal joints of last coppery.

Head lightly excavate, longitudinally canaliculate, densely and finely punctate.

Prothorax. Apex and base bisinuate, narrowing from base to apex in slight curve, anterior angles obtuse, posterior acute from above, upper carina continuous to apex, lower unseen from above, surface finely transversely stitigose, transversely depressed near posterior angles. *Scutellum* large, transversely oval with triangular extension behind. *Elytra* with fine silky surface having minute scale-like divisions, scarcely punctate, apices separately rounded, their margins minutely serrulate, underside minutely punctate. *Dim* 7 x 2½ mm

Hab—Queensland. Cooktown (H. Hacker, in Melbourne Mus.), Herbert River (Queensland Mus.)

Three specimens of this brilliant little Ruprestid are before me. In colour it is similar to *Melobasis cyaneipennis* Boh. (except for the elytral pubescence) and unlike any described species. Type in National Museum, Melbourne.

CISSEIS CARENICEPS, n sp. (Text-fig 8)

Elongate olliptic, navicular. Head, pronotum, underside and appendages coppery bronze, elytra varicoloured, two examples chiefly violaceous, tinged cyaneous, the third example bluish-green, in all cases the suture (narrowly), apex and apical margins fiery coppery.

Head rather flat, with a dense longitudinal system of puncturation, and a well raised longitudinal carina in middle extending from between the antennal orbits to half-way between the eyes.

Prothorax. Apex lightly, base strongly bisinuate, laterally convex, sides nearly straight, gently narrowed from base to apex, anterior angles obtuse, posterior acute (both from above), disc transversely striolate, rugose at sides, upper lateral carina unusually short, terminating some distance from apex. *Scutellum* transversely triangular. *Elytra* subparallel on basal half, finely narrowed at apex, apical margins minutely serrulate, disc irregularly punctate, punctures dense near base, finely scalose-punctate near suture and apex, rather coarsely, transversely rugose-punctate on rest. Underside transversely striolate, with some faint lateral impressions on abdominal segments. *Dim* 8.9 x 3 mm

Hab—Western Australia (Du Boulay) and N.S.W. (Saunders' Coll.)

Three examples, labelled as above in the British Museum, show a species of

iridescent pattern, remarkable for the well developed frontal carina and absence of elytral pubescence

C. subcaenifrons Thoms. from King George's Sound, besides colour differences, has the following characters at variance with the above (1) "caput-linea media longitudinale obsolete instructum", (2) Prothorax "subglobuloso-cylindricus, nec transversus", (3) 7 mm long Type in British Museum

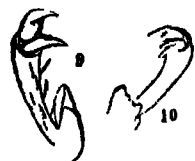
NEOSPADES Black

Distinguished from *Cisseis* by (1) the lateral claws strongly bifid, (2) the basal joints strongly compressed, the posterior with basal joint scarcely longer than the second. The head is more or less bilobed, which is very exceptional in *Cisseis*, and the form, in general, parallel and convex

Neospades forms a convenient subdivision of the larger genus *Cisseis* (See Text-figs 9 and 10 for characteristic claws of *Cisseis* and *Neospades*)

Table of species

- | | | | |
|----|----|--|-----------------------------|
| 1 | 7 | Elytra chiefly golden, or green with blue or purple marking, with or without pubescent impressions | |
| 2 | 4 | Blue markings consisting of two spots and a post-medial fascia | |
| 3 | | Ground colour fiery copper, apex non pubescent | <i>cruciata</i> F |
| 4 | | Ground colour golden green, apex with two pubescent spots | <i>cuprifera</i> Gestro |
| 5 | 7 | Darker markings covering wide apical area with pubescent spots thereon | |
| 6 | | Darker markings continuous along suture, to base, sides of pronotum nearly straight | <i>lateralis</i> Blackb. |
| 7* | | Darker markings not continuous to base, sides of pronotum rounded | <i>chrysopygia</i> Germ |
| 8 | 14 | Elytral markings consisting of pubescent spots on a unicoloured ground | |
| 9 | 11 | Ground colour of elytra dark form subcylindric | |
| 10 | | Whole surface dark bronze, tinged violaceous | <i>gouldi</i> Hope |
| 11 | | Pronotum golden coppery, elytra dark blue | <i>simplex</i> Blackb |
| 12 | 14 | Ground colour brilliant golden green | |
| 13 | | Elytra with two pubescent spots close to apex—the subapical spots clearly separate | <i>viridaenea</i> MacL. |
| 14 | | Elytra without pubescence close to apex—the subapical pubescence sub-fasciate | <i>terrae-reginae</i> Théry |
| 15 | 17 | Elytra without pubescence | |
| 16 | | Colour bronze-black | <i>nigro-aenea</i> Kerr. |
| 17 | | Colour golden green | <i>viridis</i> Kerr. |



Synonymy—(a) *lateralis* Blkb = *splendida* Kerr
 (b) *chrysopygia* Germ = *dimidiata* MacL = *apicalis* MacL.
 = *purpureo-tincta* MacL = *semi-rugosa* Thoms = ? *semi-scabrosa* Thoms

(c) *cuprifera* Gestro = *cuprifera* Thoms

(d) *simplex* Blackb = *bella* Blackb = (?) *nigripennis*

MacL = *ignicollis* Kerr

(e) *viridis-aurea* MacL = *nitida* Kerr. = *viridicuprea* Kerr

† Text-fig 9

‡ Text-fig 10

* *N. Picta*, nsp, described below was received after this manuscript was complete, and would follow *chrysopygia* in the table

† Hind tarsal claw of *Cisseis leucosticta* Kirby

‡ Hind tarsal claw of *Neospades lateralis* Blackb

(a) Types compared The example of *lateralis* (cotype) in the Kennemans Coll was abnormally coloured, and evidently misled him

(b) I have previously recorded the synonymy of Macleay's three species with *semirugosa* Thoms I now accept Blackburn's determination of *chrysopygia* Germ. for examples in the South Australian Museum, which are clearly conspecific The species is common and widely spread in Queensland, South and Western Australia.

VAR

Two examples in the British Museum and one in the South Australian Museum have pubescent spots irregularly scattered over the apical half of elytra, besides the two regular spots usually found in this species

(c) Previously recorded by me (Arkiv for Zoologi, Band 13, No 22, 1920)

(d) I have above noted the strong similarity between *N simplex* Blackb and *Cissens cuprescollis* Hope The description as to colour "viridis, aureo-micans, elytris apicis obscure-aeneis" is misleading The type has the pronotum and underside a brilliant golden green, the elytra are blue-black with pubescent spots (in fresh specimens in my collection, violet or clear blue as in *C. 12-maculata* F) with coppery tints at suture and apex When the pubescence is abraded, the forms like *bella* and *ignicollis* appear, and I believe *nigripennis* MacI to be a discoloured example of the same

(e) I have closely compared the types, and find only slight differences of size and colour

Terrae-reginae Théry is very near *viridi-aurea* MacI but has its pubescence differently placed, *inter alia*

Nigro-aenea Kerr is differentiated from *viridis* Kerr, not only by colour, but by the close and deep sculpture of the former Both are from Queensland

NEOSPADES PICTA, n sp

Oblong, lightly attenuate in front and behind, head pronotum, basal parts of elytra, underside and appendages nitid coppery bronze, apical two-thirds of elytra brilliant violet with preapical and medial pubescence

Head coarsely, not very closely punctate, forehead sub-bilobate (as in *Cissens pygmaeus* Blackb.), eyes large and prominent

Prothorax transverse, apex strongly produced in middle, base bisinuate, sides rather straight, the inferior carina evident from above, widening from base to near apex, thence arcuately narrowed, whole surface coarsely, concentrically rugose, about a smooth oval spot situated at the apex of the front medial production Scutellum transverse with a triangular extension behind, coarsely punctate Elytra of same width as prothorax, separately rounded at apex, the bronze area extending to basal third at suture, nearly half-way at sides, the violaceous area thus forming an oval extension near suture. Pubescent markings (1) a sub-fasciate preapical one, consisting of a rounded patch on each side of suture and a disconnected transverse one extending to sides, (2) a more vague medial pubescence evident on sides, subobsolete on disc. Surface coarsely scalose-punctate, the scales arranged in irregular transverse ridges, these coarser on bronze, lighter on violet areas, underside lightly punctate Dim 6 x 2 mm

Hab—Queensland. Brisbane (G. H. Hardy)

Two examples from the Queensland Museum show the typical *Neospades* structure—cylindric form, lightly divided head and forked claws. In one example the head is more brilliantly metallic than the pronotum, with a tendency to green at the sides. In my tabulation the species would follow *chrysopygia* Germ., from which it differs in its smaller, especially narrower, form, in its less deeply rugose surface, besides colour. Type in the Queensland Museum.

HYPOCISSEIS Thoms

(= *Maschalix* Waterh = *Cisseoides* Kerr.)

- | | | | |
|----|----|--|---------------------------|
| 1 | 10 | Colour blue-black or black, with white pubescence | |
| 2 | 4 | Form wide obliquely narrowed in front and behind | |
| 3 | | Head widely excavated, crested near eyes | <i>latipennis</i> MacL |
| 4 | | Head lightly excavated, without frontal crests | <i>brachyformis</i> Deyr |
| 5 | 10 | Form elongate oblong | |
| 6 | | 12 mm long head widely excavated, eyes bordered within by narrow ridge | <i>piloscollis</i> Blackb |
| 7 | | 8.9 mm long, head lightly excavated, front scarcely ridged | |
| 8 | 10 | Head bilobed (somewhat as in <i>Ethon</i>), frontal lobes extended in front of eyes | <i>suturalis</i> Saund |
| 9 | | Sub-apical pubescence vague and straight | <i>cyanura</i> Kerr |
| 10 | | Sub-apical pubescence forming parallel zig-zags | <i>minuta</i> , n.sp |
| 11 | | Colour bronze with blue markings head widely excavated and ridged | <i>ornata</i> , n.sp |

Notes and Synonymy of the above

Hypocisseis Thoms = *Maschalix* Waterh = *Cisseoides* Kerr.

Waterhouse seems to have been unaware of Macleay's species in describing *Maschalix latipennis* as well as of Thomson's genus erected for the reception of *Cisseis latipennis* MacL. *Cisseoides* is to my mind superfluous, its distinctions from *Hypocisseis* being slight and of doubtful value. Kerremans himself described *aeneipes* (infra) as a *Hypocisseis*.

(a) *H. (Cisseis) latipennis* MacL = *cornuta* Gestro = (*Maschalix*) *latipennis* Waterh = *lateornis* Thoms

(b) *H. (Coraeus) piloscollis* Blackb = *Cisseoides murina* Kerr

(c) *H. (Cisseis) suturalis* Saund = *Coraeus marmoratus* MacL. = *Cisseoides albopuncta* Kerr = *Hypocisseis aeneipes* Kerr

(d) *H. (Cisseoides) cyanura* Kerr. = *C. modesta* Kerr

With regard to (a), I have seen the types of Macleay and Waterhouse while the descriptions of *cornuta* and *lateornis* make this synonymy certain.

(b) Types examined at different times by me—but I am satisfied as to their identity.

(c) Examples compared with Macleay's type are in my Collection—the other types have been closely compared. This species is widely distributed from Queensland to Western Australia, and variable in size, and sometimes in appearance through abrasion of its pubescence.

(d) The two types show slight colour variations only. *H. brachyformis* Deyr, described from Myzole, is also found in Queensland. I have two examples from Rockhampton taken by Mr H. W. Brown. It differs from *latipennis* in smaller size, flatter head, absence of frontal crests, the pronotum not channelled, its sides rounded, its legs dark inter alia.

HYPOCISSEIS MINUTA, n. sp. (Text-fig 11)

Oblong ovate, blue-black, elytra with transverse undulate impressions of white pubescence, underside and appendages cyaneous.

Head canaliculate and divided, somewhat as in *Ethon*, but the bilobed front produced in front of the eyes and more or less clothed with coarse, yellow hair, surface at vertex nearly smooth or very finely rugose.

Prothorax very transverse convex, apex and base bisinuate, sides widely rounded, the two carinae enclosing a small narrow area, the convex disc surrounded at base and sides by horizontal depression more clearly cyaneous than the rest—the finely rugose sculpture largely concealed by shagreen clothing. *Scutellum* large, transversely oval. *Elytra* oval, rather widely rounded at apex, apices scarcely separately rounded, and minutely serrulate, on apical area two parallel zig-zag pubescent impressions, a third and fourth similar impressions, decreasingly defined in proportion to distance from apex, a fifth vaguely-seen lunate pubescence behind scutellum from shoulder to shoulder. Surface elsewhere finely rugose, abdomen with a fine, short pubescence, breast minutely punctate. *Dim* 4.5 x 1.7-2 mm.

Hab—Queensland Johnstone River (H. W. Brown), Cape York (Coll. Carter).

Four examples in the South Australian Museum, also 3 in Coll. Carter (one from C. York) show a species near *cyanura* Kerr (= *modesta* Kerr) of which I have seen the types. *Minuta* is distinguished from this, *inter alia*, by (1) lobes of head being pressed closely together—in *cyanura* widely V-shaped, (2) different pattern of elytral impressions—straight in *cyanura*. Types in South Australian Museum.

N.B.—There is only a slight colour difference between the unique types of *cyanura* and *modesta*—both from Gavndah.



Text-fig 11

*Hypocisseis
minuta*, n. sp.

Text-fig 12

H. ornata, n. sp.

HYPOCISSEIS ORNATA, n. sp. (Text-fig 12)

Oblong, bronze, subnitid with the following markings: cyaneous a transverse fascia at base of pronotum, elytra with post-humeral spot and preapical fascia, interrupted at suture.

Head A deep concavity between eyes, the sides or flanges of concavity jutting beyond the eyes, each flange with a large fovea within, eyes rather flat, width of head less than that of prothorax at apex. *Prothorax* convex and uneven in surface, rather gibbous and subangulately produced at apex in middle, base bisinuate, widest at middle, basal half subparallel, thence subangulately narrowed to apex, upper carina very short and sinuous, widely separated from lower carina in front, irregularly, transversely depressed near base, the depression more or less cyaneous. *Elytra* oblong-acuminate, obliquely narrowed behind, with four longitudinal callosities near base, one on each side of scutellum, and one on each shoulder, the latter connected with a little raised costa extending obliquely from shoulder to middle of elytra near apical declivity, a transverse gibbosity also behind scutellum. Surface closely and finely punctate, the cyaneous markings vaguely outlined by white pubescence. Underside glabrous and more coarsely punctate. *Dim* 4½-6 x 2-2½ mm.

Hab—South Australia Lucindale (Feneberg), Western Australia Geraldton (W D Dodd)

Eight examples of this pretty little insect examined. The arcuately excised head is somewhat as in *suturalis* Saund., or (*Coraeus*) *pilosicollis* Blackb., but the excision is deeper and wider. In two examples the blue markings on thorax and side of elytra are not very clear. The species is a bridge between *H latipennis* MacL. and *suturalis* Saund. Types in the South Australian Museum.

ALCINOUS Deyl

Ann Soc Ent Belg, 1864, p 115, Kerr, *ibid*, 1898, p 174

Synonymy—*A nodosus* Kerr = *A minor* Kerr

I have examined the types and consider them mere variations of a species that I have taken in many localities of Eastern Australia. The genus is somewhat intermediate between *Cisseis* and *Agrius*, of shorter form than the latter, and readily distinguished from *Cisseis* by its irregular, nodulose surface. Like *Cisseis* it also occurs on foliage, chiefly *Acacia*—in the coastal brush areas of Queensland and New South Wales, but I have also taken an example at Yea, Victoria.

THE LIFE HISTORY OF *MICROCACHRYS TETRAGONA* (HOOK.)

By A. ANSTRUTHER LAWSON, D.Sc., Professor of Botany, University of Sydney

(Plates xv-xvi and Thirty-four Text-figures)

[Read 30th May, 1923]

Microcachrys tetragona (Plates xv-xvi) is one of the rarest and at the same time one of the most interesting of the Coniferales. It is a low, creeping, profusely branching shrub inhabiting the higher mountain tops of Central and Western Tasmania. It clings very closely to the windswept and often snow-covered rocks and, with its numerous small branches and closely imbricate scale-like leaves in four rows, it is a remarkable adaptation to high alpine conditions. Its habit and habitat, together with its crimson coloured succulent cones, present features quite unusual among gymnosperms. Its geographical distribution is limited to the higher elevations of the Tasmanian mountains. As a monotypic genus it was first described by Hooker in 1845.

Its rare occurrence and the inaccessible regions it inhabits doubtless account for our lack of knowledge regarding its life-history. With the exception of a brief note on the pollen by Thompson (1908 and 1909) we have no knowledge of the gametophytes of this interesting genus of the Podocarpaceae.

It seems very desirable that this and other little-known Australian Conifers should be investigated, with the hope of filling in the gaps in our knowledge of this great sub-division of the Gymnosperms.

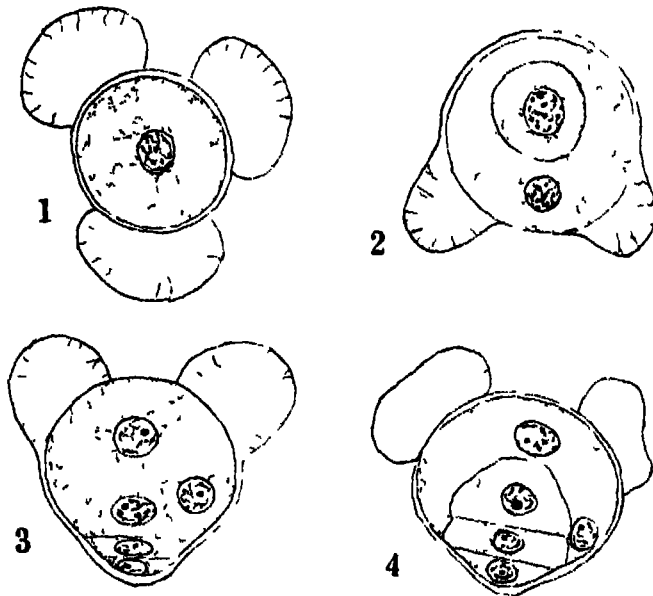
Being within fairly easy distance of Tasmania and the mountains inhabited by *Microcachrys*, I have been enabled, as a result of a number of expeditions, to obtain a complete series of developmental stages of the gametophyte structures, fertilisation, and embryo of this rare genus.

A very considerable amount of the material forming the basis of this investigation was collected and fixed in the field. Some of it, however, was from time to time sent by post. In such cases the specimens were carefully packed in moist *Sphagnum* and reached my laboratory, generally within forty-eight hours, in the living condition. Upon its arrival, the specimens were immediately dissected and fixed in dilute chrom-acetic acid and otherwise prepared for imbedding in paraffin. From these two sources enough material was secured to show all the essential details of the life-history.

The Male Gametophyte

From a study of the living microspores it became quite evident that the pollen is winged. A superficial observation under the microscope might lead one to the conclusion that there were two wings present. But a slight pressure on

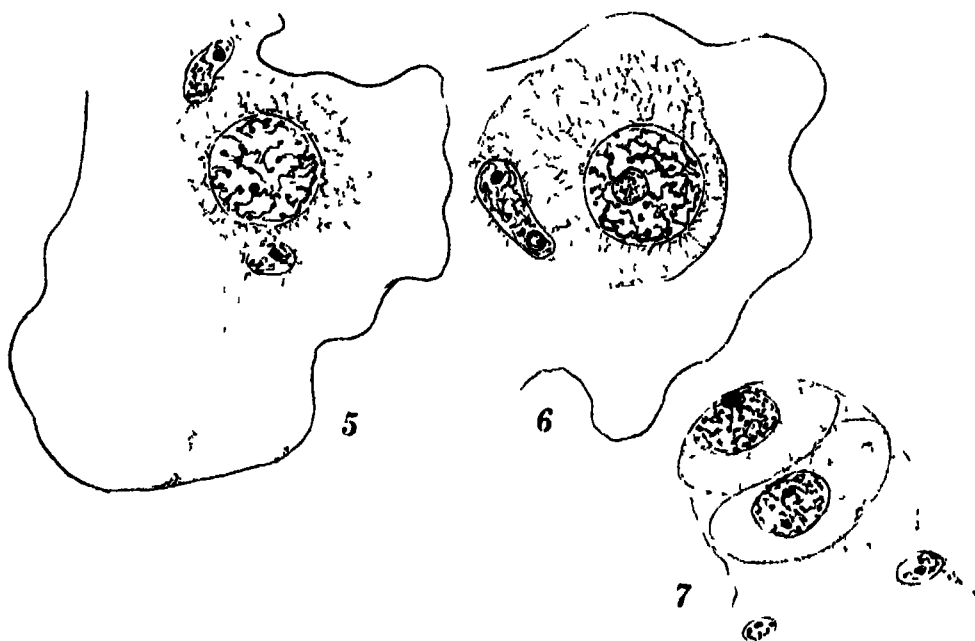
the cover glass will cause the microspores to turn or roll and the presence of a third wing is easily demonstrated. From a study of a series of stained sections through the microsporangium, the presence of three wings was abundantly confirmed. These wings which are inflations of the spore-wall are arranged in a perfectly symmetrical fashion, as indicated in Text-fig 1. This figure represents a section of a microspore showing only one nucleus. The thickness of the spore-wall and the contained dense cytoplasm is indicated. I was unable to detect any noticeable difference in the size or shape of the wings. In many of the sections, portions of the wings were removed in the cutting, giving an unsymmetrical appearance but in the thousands of living microspores examined there was a remarkable uniformity. Text-fig 1 may be taken as a very fair sample of the three inflations or wings. From living material collected in the field I have not found any microspores with more than three wings. In this connection Thompson (1909) has reported a slight variation.



- Text-fig 1 —A section of a microspore showing one nucleus. The thick cell wall is dilated in three places, forming three wings of equal size and symmetrically arranged. Dec 10th, 1921.
- Text-fig 2 —A section of a microspore showing two of the wings, the wall of the body cell is clearly indicated as well as the tube nucleus. Dec 10th, 1921.
- Text-fig 3 —A section of a microspore showing two prothallial cells, a tube nucleus, the generative cell has just divided to form the body cell and stalk nucleus. Dec 10th, 1921.
- Text-fig 4 —A section of a mature microspore at the time of pollination. Here only two of the three wings are shown. Within the spore which has germinated there are two prothallial cells, a large central body cell, a stalk nucleus and a tube nucleus.
(Figs 1, 2, 3, 4 x 1000)

In regard to the contents of the microspore, I find that the mature pollen grain at the time of pollination has within it three cells and two free nuclei

Under favourable conditions these could be observed in the living state. Text-fig 4 may be taken as typically representing a median section of a microspore at this time. It will be observed that the three cells are separated from one another by thin but sharply defined cell walls. The three nuclei of these cells lie directly one after the other in a straight line and one of the free nuclei lies behind in the same line. The other free nucleus is invariably at one side. There are thus four nuclei in a row and one excentrically situated. My interpretation of these structures is as follows.—The two smaller cells nearest the spore-wall are the two prothallial cells, corresponding to the two prothallial cells so characteristic of the Abietineous pollen (Coulter and Chamberlain, 1901, 1910). The large centrally-situated cell is the body-cell and the excentrically-situated free nucleus is the stalk nucleus. The remaining free nucleus is the tube nucleus. Although many hundreds of microspores were examined, both in the living condition and in the



- Text-fig 5 —A section of the tip of the pollen tube showing the large spherical body cell and the stalk nucleus, and the tube nucleus suspended in the tube cytoplasm. The tube nucleus is just forward of the body cell. Feb 6th, 1922.
- Text-fig 6 —A slightly older condition of the above. The body cell loses its spherical form and its nucleus prepares for mitosis. Feb 6th, 1922.
- Text-fig 7 —From a section of a pollen tube near the tip. The body cell has divided to form two sperm cells of approximately equal size. The stalk and tube nuclei are also shown. Feb 6th, 1922.
- (Figs 5, 6, 7 x1000)

sections, I was unable to find a single instance of a microspore containing more than five nuclei, namely, those of the two prothallial cells, that of the body-cell, the stalk nucleus and the tube nucleus. I am therefore unable to confirm Thompson's (1909) observations in this connection. Text-fig 3 represents a stage slightly earlier than that represented in Text-fig 4. Here the two prothallial

cells are fully organised, but the stalk and body cells are not. Evidently this is a stage where the generative cell has just divided and the wall separating the body cell from the other structures is not completed. Text-fig 2 is taken from a section of a spore containing the tube nucleus and the body cell. It is intended to show how clearly defined is the wall of the body cell from this view.

Text-fig 22 shows the manner in which the microspores are deposited—evidently driven by the wind—in the micropyle. Here these microspores may be seen with their winged inflations and their nuclear contents. The reflexed extension of the integument is very characteristic and probably assists in the retention of the microspores. Upon reaching the apex of the megasporangium, the microspores continue their germination, by producing a pollen tube. In Text-fig 25 one may observe how the pollen tube penetrates the nucellar tissue. At the apex of the megasporangium a sharply defined cushion of tissue which, in another investigation, I have referred to as the pollen cushion (Lawson, 1910) is organised. Through this the pollen tube descends, dissolving the nucellar tissue in its advance, carrying the body-cell and the tube and stalk nuclei at the tip. As the archegonial chamber is reached the tube dilates and spreads over the apical region of the prothallus. Text-figs 26 and 27 show the dilated tip of the pollen tube with its contents. During the descent of the pollen tube, the body-cell gradually grows until it is many times its original size. It assumes an almost perfectly spherical form and its large, centrally-situated, deeply-staining nucleus is a conspicuous feature in the section. Text-fig 5 represents the tip of the pollen tube at this time. The large body-cell is here seen suspended in the dense mass of cytoplasm. It has a very thin but well defined cell-wall and on either side of this are the stalk nucleus and the tube nucleus respectively. I can interpret these three structures in no other way than that they are the same three structures indicated in the microspore (Text-fig 4), the two prothallial cells having remained in the spore on the apex of the nucellus (Text-fig 25).

Text-fig 6 represents a pollen tube slightly older. Here the body-cell has enlarged still more. It has lost its spherical form and its nucleus is preparing for mitosis. The stalk nucleus is seen at one side.

The actual division of the body-cell was not observed, but in one instance the result of this mitosis was clearly seen. This is shown in Text-fig 7. There are evidently two sperm cells formed, each with its own thin cell-wall. As these two sperm cells were pressing closely together it was difficult to say whether there was any difference in the size. Apparently they were approximately equal.

The male gametophyte and details of spermatogenesis of *Microcachrys*, while essentially resembling *Podocarpus*, show some striking differences (Burlingame, 1908). For *Podocarpus*, Coker (1902) reports as many as six nuclei in the mature pollen grain. He states, however, that this is probably abnormal. It is to be noted also that in *Podocarpus* there is but one functional male cell. In *Microcachrys* the male gametes are probably both functional.

The Female Gametophyte

The ovulate strobili are situated at the ends of short branches, and although, in the mature state, they are bright red in colour they are not conspicuous in the field, being more generally hidden by other sterile branches. A perfectly median section of a very young sporophyll is shown in Text-fig. 28. It will be seen that the bract grows nearly at right angles to the cone-axis for the greater part of its length, but at a point near its distal end it turns sharply in a vertical direction. At this point, on the adaxial face of the sporophyll, is situated the megasporan-

gum with its integument, it being protected by the upward growth of the apex of the sporophyll which is now recurved towards the axis. The scale at this early stage follows a course in its growth almost parallel with that of the distal end of the sporophyll. It should be pointed out that there is only one ovule to each bract and this latter, even at this early stage, as shown in Text-fig. 23, is recurved in its growth until it is directed in a line with its micropyle towards the cone-axis. The extended mouth of the inner integument projects for a considerable distance beyond the nucellus and recurves in a downward direction towards the bract, forming quite a long tube-like micropyle. Typical instances of this feature are illustrated in Text-figs. 22, 23 and 24. In Text-fig. 24 the single vascular strand may be seen supplying the sporophyll and branching into the ovule. The large, loose, thin-walled cells seen at the curvature of the sporophyll are an indication of the future succulent nature of this tissue.

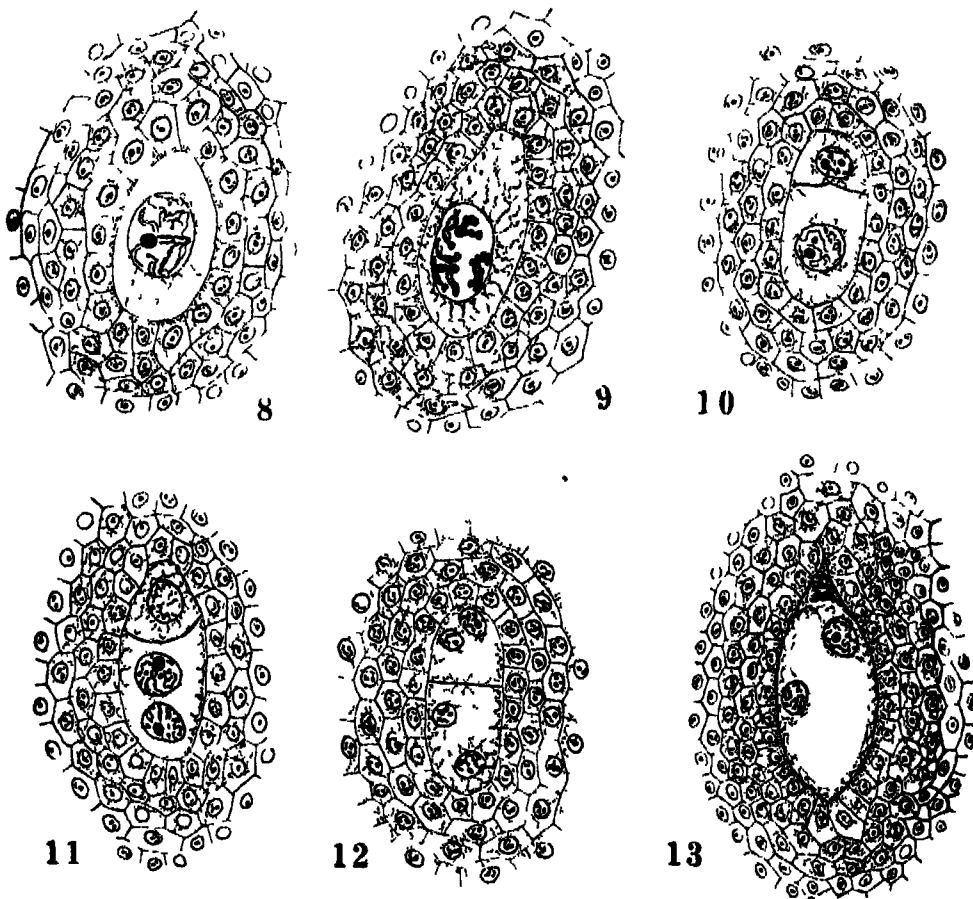
The conditions here described are those found at the time of pollination. The microspore cones are produced in great profusion and the resulting pollen produced is very great indeed considering the size of these dwarf plants. The driving winds in these exposed alpine regions cover the plants with pollen so that very few ovules escape its reception (Text-fig. 22).

At this time the megaspore mother-cell makes its appearance. In the very early condition it is difficult to distinguish this from other nucellar cells, but at a point in line with the base of the integument a single mother-cell becomes distinctly differentiated. It is larger, clearer and has a much more conspicuous nucleus than the neighbouring cells. The cells immediately surrounding it also undergo a change and become a well defined tapetum of two or three cells deep.

The first appearance of the mother-cell is shown in Text-fig. 23, slightly older stages are indicated in Text-figs. 22 and 24 in which the tapetum is shown. A somewhat older stage is shown in Text-fig. 21. This is from a transverse section to show the relationship of the integument with the nucellus. In the centre is a large mother-cell preparing for reduction division and surrounded by three layers of tapetal cells.

I was fortunate enough to secure an almost perfect series of stages in megasporogenesis. From the abundance of material at hand it seems quite clear that only one megaspore mother-cell is organised. A very typical appearance of this cell is shown in Text-fig. 8. The relative size of this cell with its large nucleus is very striking. It is many times greater than the largest of the surrounding tapetal cells. The cytoplasm of this mother-cell, while finely granular, is much more clear than the dense cytoplasm of the surrounding tapetum and hence stands out in the greatest possible contrast. Although the actual spindle was not found, all the essential details of the sporogenesis were observed. In Text-fig. 8 the nucleus is represented in the spireme state. The long thread-like chromosomes are clearly defined and are evidently split lengthwise. In Text-fig. 9 one sees the chromosomes actually uniting in pairs, which results in reduction. The number of the chromosomes seems to be twelve but, as the specimens examined in these stages were limited, further confirmation is necessary. Twelve were found in about twenty nuclei. There is no doubt, however, that this is a phase of the reduction process. The result of this first meiotic division is shown in Text-fig. 10. Traces of the spindle fibrils are still seen stretching between the daughter-nuclei and a distinct cell-wall separates the latter from one another. This division is evidently immediately followed by another. The two daughter-nuclei divide, but apparently not simultaneously. Text-fig. 11 shows one of these divided and the other near the micropolar end still undivided. In Text-fig. 12 both these nuclei

have divided so that the four megasporites are represented at this time by two cells each with two nuclei. At the completion of this second meiotic division, walls separate all the nuclei, so that there are four separate cells forming an axial row. Only one of these megasporites functions, the proximal one, that nearest the food supply. The other three degenerate and appear as flattened masses of



Text-fig 8 —From a section taken in a median line through the megasporangium. In the centre of the figure is the large megaspore mother cell surrounded by a well developed tapetum. Dec 10th, 1921

Text-fig 9 —From a similar section to Text-fig 8. Here the nucleus of the megaspore mother cell is in the first state of meiosis. The bivalent chromosomes are uniting in pairs. A well organised tapetum is also indicated. Dec 10th, 1921

Text-fig 10 —A section to show the result of the first meiotic division of the megaspore mother cell. Two cells are now formed, each with its own nucleus, and separated from one another by a distinct membrane. Dec 10th, 1921

Text-fig 11 —A similar section to show the result of the second meiotic division. Here one of the nuclei shown in Text-fig 10 has divided. There are now one cell and two nuclei in the axial row. Dec 10th, 1921

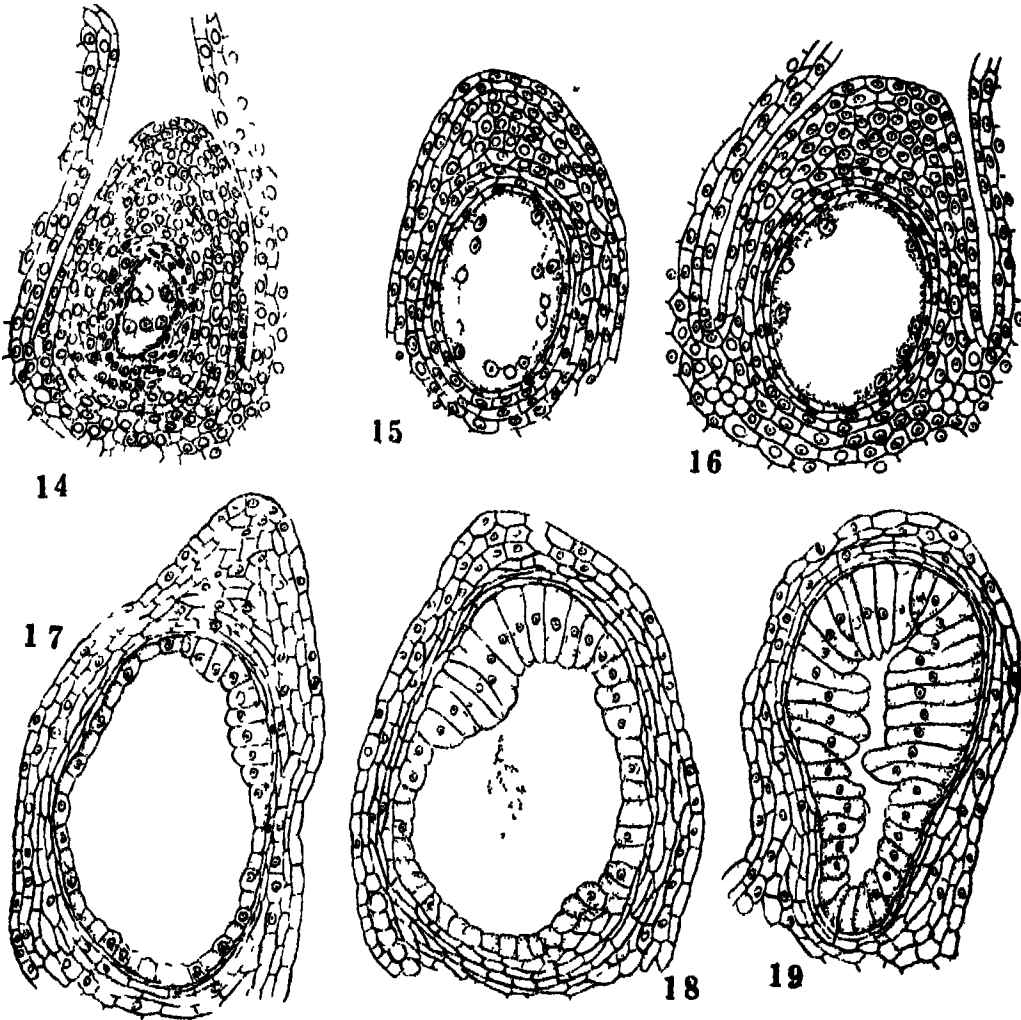
nuclear substance at the distal end of the functional spores. This latter has meantime enlarged many times its original size. Text-fig 13 is a typical example of numerous instances found of this condition. During its growth an immense vacuole is developed in the centre of the germinating megaspore and this forces the cytoplasm to occupy a parietal position. At this time the tapetum has reached its maximum development. These features are well illustrated in Text-fig 13. The nucleus of the megaspore now immediately undergoes a series of free divisions and the nuclei thus formed take up positions in the parietal cytoplasm (Text-figs 13, 14, 15). This is the first instance in which the essential details of megasporogenesis have been reported for the Podocarpaceae. In the near future I shall compare these stages with others which I have under investigation. This series of events leading to the mature functional megaspore is essentially the same as that in *Sciadopitys* (Lawson, 1910). With this development the tapetal cells undergo degeneration and their substance is evidently absorbed by the germinating megaspore. As shown in Text-fig 14 the tapetum has completely vanished and the inflated megaspore, with its numerous free nuclei and large central vacuole, presses and flattens out many of the nucellar cells with which it comes in contact (Text-fig 15 and 16). So far there is no indication of a cellular prothallus, the young gametophyte consisting of the large central vacuole enveloped by parietal cytoplasm and at least sixty-four free nuclei. But soon after this stage shown in Text-fig 16, the mitoses result no longer in free nuclei. Each cell that is now formed is completely surrounded by a cell wall. So that, instead of parietal cytoplasm, there is a single row of narrow cells lining this cavity. Of all the Gymnosperms I have examined, I have not found such beautiful examples of this so-called "Alveolar" structure, first discovered by Sokolava (1880) and described by Arnoldi as "alveoli" (1900).

These cells are apparently first formed at the distal end of the vacuole and gradually come to line the whole space occupied by the parietal cytoplasm. While the cells or "alveoli" are being formed in the proximal end the entire mass of the parietal cytoplasm is not included within their walls. Many preparations showed considerable masses of this outside the cell-walls as for instance shown in Text-fig 18. This figure also shows the rapid elongation of these "alveoli". The rapid growth of these cells into long tubes, each at first with a single nucleus, is doubtless assisted by the absorption of the vacuolar sap. For this latter now becomes less and less until the entire space it once occupied is encroached upon by the "alveoli". A very fair example of this condition is shown in Text-fig 19. Here the primary cells of the young prothallus are seen to have elongated to such an extent that the vacuole has nearly vanished. The rate of growth of these primary cells is not uniform. Those at the distal end appear to have a greater growth than those at the opposite end. Eventually, however, as was observed in both longitudinal and transverse sections, the vacuole becomes entirely obliterated.

Text-fig 12 —A similar section to show the second cell shown in Text-fig 10 has divided. The separating walls have not yet been laid down. There are eventually four cells in the axial row. These are the megaspores. Dec 10th, 1921

Text-fig 13 —From a similar section a few days older. The proximal cell of the axial row has grown to a great size and becomes the functional megaspore. The other three cells become aborted and appear as three nuclear masses pressed into the tissues of the tapetum which still persists. The nucleus of the megaspore has divided to form two free nuclei. Dec 10th, 1921
(Figs 8-13 x 550)

and then the mitoses following result always in cell-walls being formed. Occasionally it was observed that these primary prothallial cells had two or even three nuclei, but the resulting smaller cells have only one. The prothallial cel-



Text-fig 14 —A section through a median-line of the megasporangium, at a much lower magnification than the preceding six figures. Here the megaspore has continued its germination and its nucleus has undergone repeated free nuclear division. The tapetum is in a state of disorganisation and rapidly being absorbed by the developing prothallus. Jan 21st, 1922.

Text-fig 15 —A later stage of the same. Here the tapetum has completely vanished and the megaspore has increased to many times its original size. Free nuclear division has preceded and the large clear central vacuole forces the cytoplasm into a parietal position and here the free nuclei take up their position. Jan 21st, 1922.

lular tissue is thus formed. The original line of cells set down in the early stages by the elongated primary prothallial cells is retained in the mature prothallus. Text-fig. 27 represents a longitudinal section of the upper half of the prothallus. Here, on either side of the archegonia, the curious rows of cells are those originally laid down in the "alveolar" style.

The archegonial initial was not observed. Many preparations showed the mature archegonia. Curiously enough these are developed close together in a single group after the manner of the Cupressineae (Lawson, 1907, Coker, 1903). A common nourishing jacket two or three cells deep envelopes the archegonia. There is likewise a single common archegonial chamber into which the tips of the pollen-tubes enter. Each archegonium is three or four times as long as broad. There are four neck cells and a large vacuole in the lower half of the cytoplasm. The egg nucleus lies between this vacuole and the neck cells. As the very young stages in the development of the archegonia were not found I was unable to demonstrate the presence of a ventral canal nucleus. But doubtless this is present as it is found in so many other Taxaceae.

Among the Podocarpaceae there seems to be a considerable variation in the number of archegonia. One species of *Phyllocladus* is reported to have but one (Kildahl, 1908), and there are as many as eleven in *Podocarpus* (Coker, 1902). Five or six was the usual number met with in *Microcachrys*. A characteristic appearance of the archegonia in longitudinal section is shown in Text-fig. 27. There are three mature archegonia here shown crowded closely together and with their necks opening into a common archegonial cavity at the apex of the prothallus. These are ready for fertilisation. Text-fig. 28 is an enlarged detail of a typical archegonium to show not only the egg nucleus, vacuole and neck cells, but it shows very well the highly developed jacket cells in contact with it. The number of neck cells is four, forming a single tier. This is in sharp contrast to other Podocarpaceae, differing in this particular from *Podocarpus* (Coker, 1902) and *Phyllocladus* (Young, 1910).

A conspicuous feature of the mature gametophyte is the megaspore membrane. This is a thick tough membrane which completely envelopes the prothallus except at the apex in the region of the archegonial chamber. This membrane is so tough and thick that it interfered considerably with the fixation of the material and also with cutting sections with the microtome. The difficulty of fixation was overcome by carefully cutting away the lower portion of the ovule in such a way as to make an exposed opening for the fixing fluid to enter. This megaspore membrane is quite as thick and conspicuous as that occurring in the Abietineae.

Text-fig. 16.—The same as Text-fig. 15, but a more advanced stage. Jan 21st, 1922.

Text-fig. 17.—The same, but showing that the free nuclear division has ceased, and cells are now formed occupying the position of the parietal cytoplasm. This immense clear central area of the vacuole is now lined with a layer of closely fitting cells whose long axes are directed towards the centre of the vacuole. Each cell has a single nucleus. Jan 30th, 1922.

Text-fig. 18.—A similar section to show a further development of these primary cells or alveoli of the gametophyte. These cells are elongating towards the centre, especially those at the distal end. Jan 30th, 1922.

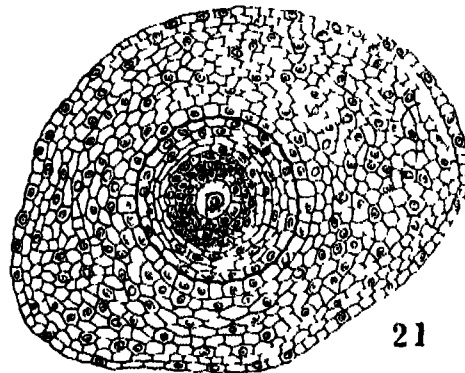
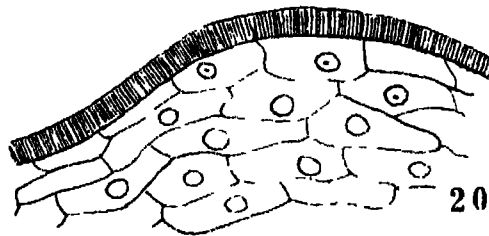
Text-fig. 19.—A later stage of the same. The primary prothallial cells or "alveoli" form a series of long tubes which in their growth encroach upon the vacuole. The latter is nearly obliterated. Jan 30th, 1922.

(Figs 14-19 x 200)

It is double-layered and suberised. It is curious that the Taxineae and Podocarpaceae should differ so consistently in this detail. In the former group (Thompson, 1905; Lawson, 1909) it is quite thin and inconspicuous, while in the latter, that is, in *Phyllocladus*, *Dacrydium*, *Saxigothaea* and *Microcachrys* it is well developed. A high power magnification of this membrane is shown in Text-fig 20.

Fertilisation

By the time the archegonia are organised, the dilated tip of the pollen tube, has reached the archegonial chamber. The course of the tube and its dilated end are shown in Text-fig 27. Here the tube is well into the archegonial chamber, and it contains the body cell and stalk and tube nuclei. These latter are usually in advance of the body cell. In Text-fig 25, one may see how very large the tip of the tube becomes as it spreads out over the apex of the prothallus. In Text-

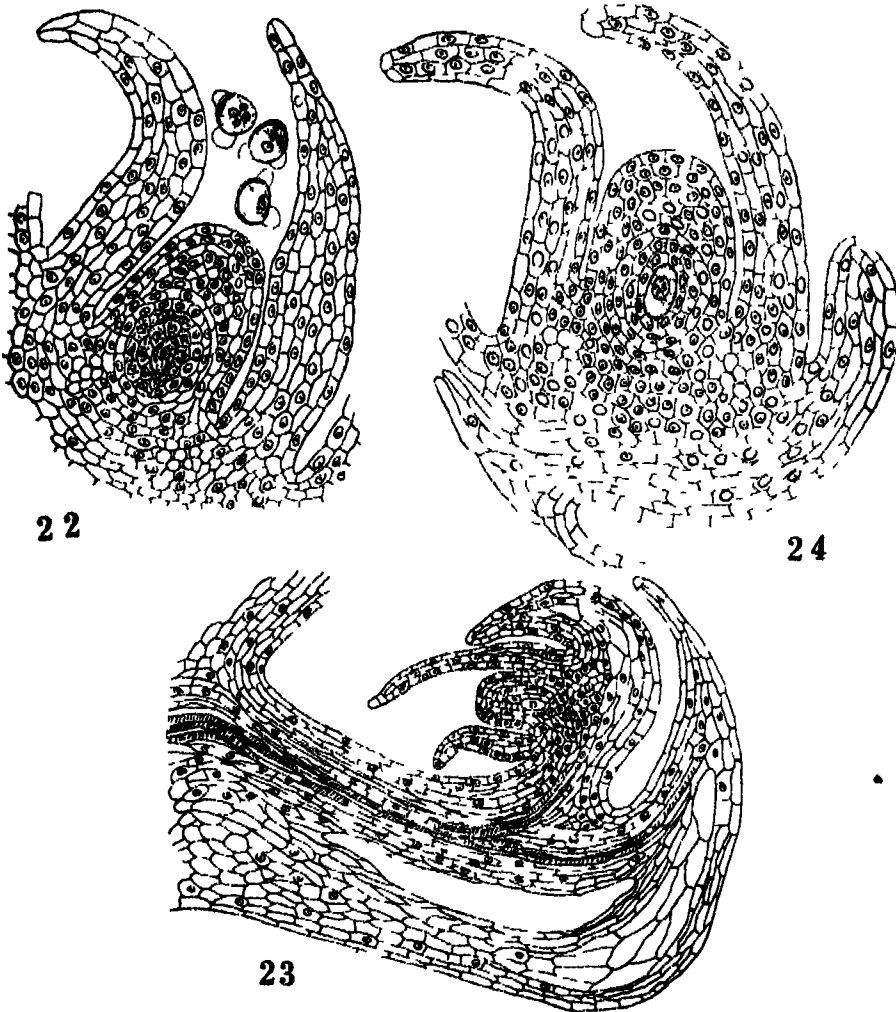


Text-fig 20 —A section of a portion of the mature prothallus showing the nature of the megaspore membrane. Feb 6th, 1922.

Text-fig 21 —A transverse section through the basal region of the megasporangium. The outer mass of tissue is the integument. The dark line marks the separation of the integument from the nucellus. The large megaspore mother cell surrounded by a three-layered tapetum occupies the centre. Dec 10th, 1921.

(Figs 20 $\times 300$, fig 21 $\times 70$)

fig 26 the nature of the body cell close to the archegonial neck is well illustrated. The sperm cells, however, have not yet been formed. The conditions shown in Text-figs 5, 6 and 7 were taken from similar positions, that is, in close proximity to the necks of the archegonia. The division of the body cell therefore does not take place until just before fertilisation. The result of this division is shown in Text-fig 7 which we have already described above. In one instance the actual penetration of the male gamete into the archegonium was observed but its actual union with the egg nucleus was not found. As the archegonia form a single

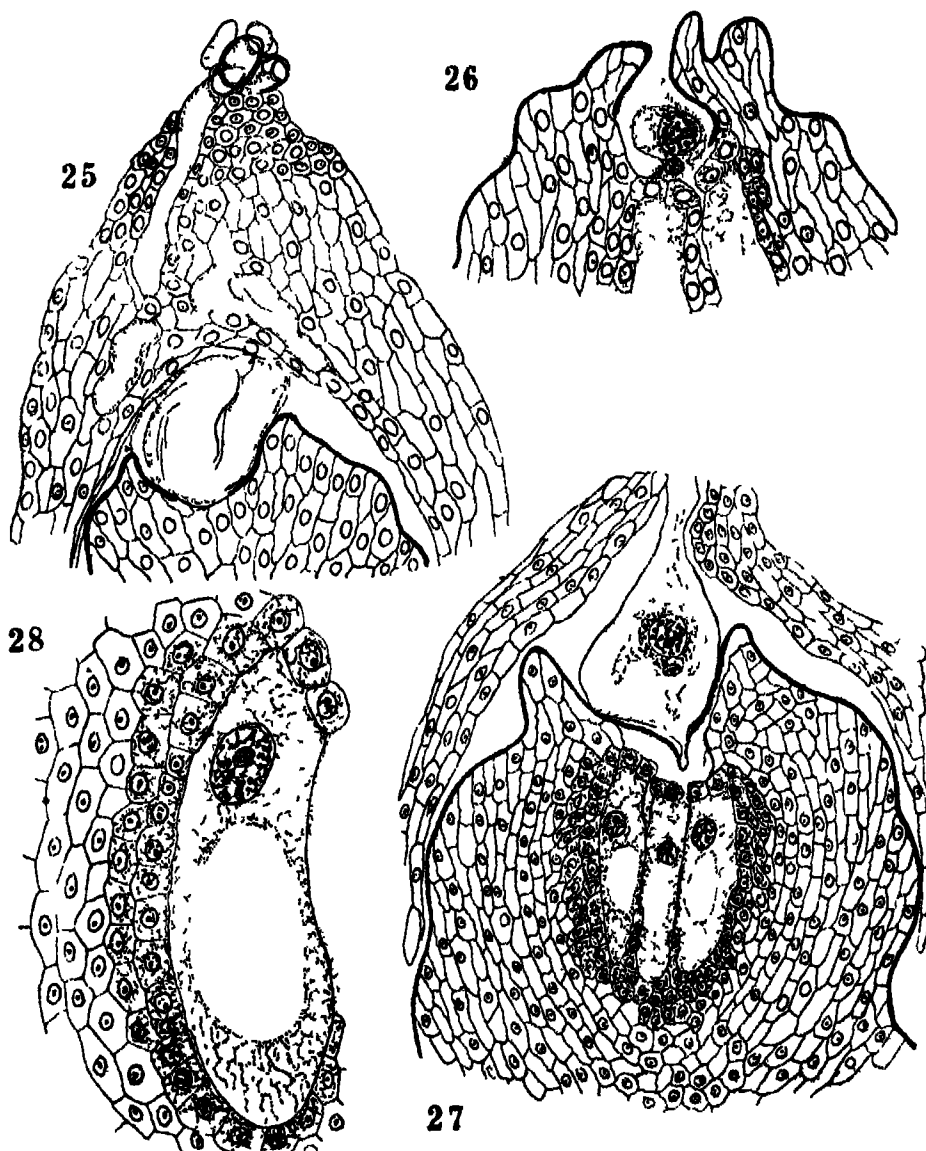


Text-fig. 22—A section taken in a median line through the megasporangium. The recurved tube of the integument is shown forming a micropyle containing three microspores. A megaspore mother cell surrounded by its tapetum is seen in the centre of the nucellus. Dec 10th, 1922.

Text-fig. 23—A median section through a megasporophyll. The characteristic position of the megasporangium with its integuments is clearly shown, as well as the characteristic position of the integument and the micropyle. This and the preceding figure were taken at the time of pollination. Dec 10th, 1922.

Text-fig. 24—A similar section of the megasporangium to show the characteristic appearance of the integument, micropyle, nucellus, megaspore mother cell and tapetum. Dec 10th, 1922.

(Fig 22 x 200, fig 23 x 100, fig 24 x 200)



Text-fig 25 —This figure represents a longitudinal section of the upper part of the megasporangium. It shows the winged microspores on the apex of the nucellus which is differentiated into a pollen cushion. The figure is to show the course of the pollen tubes through the nucellar tissue. Feb 6th, 1922

Text-fig 26 —This represents a section through the apex of the prothallus. The tip of the pollen tube has discharged its contents into the archegonial chamber. Two archegonia are seen as well as the charac-

group with a common jacket and a common archegonial chamber, it seems highly probable that both male gametes, which appear to be equal in size, are functional—fertilising different archegonia. In this respect *Microcachrys* differs from *Phyllocladus* and *Torreya** in which there is a marked difference in the size of the two gametes. In the latter two genera, one of the two male gametes is aborted. In *Cephalotaxus drupacea* (Lawson, 1907) they remain within the jacket of the mother cell until the contents of the pollen tube are discharged. It seems that in *Microcachrys* all of the archegonia were fertilised and this supports the view that both male cells in each tube are functional gametes. I am inclined to believe that the reduction of one of the gametes is an adaptation to the manner in which the archegonia are grouped or have a common archegonial chamber. When the entire contents of a pollen tube are discharged into a single archegonium one should expect one of them to be functionless. If on the other hand the archegonia necks are so arranged that the two male gametes may enter different but neighbouring archegonia one would expect them to be both functional. This is what appears to be the case in *Microcachrys*. This is very characteristic of the Cupressineae (Lawson, 1904, 1907, Coker, 1900).

The Embryo

In regard to the embryo I unfortunately was unable to find the early free nuclear condition. The early stages in the development of the suspensor, however, were frequently met with. From the appearance of the earliest condition found, it would seem that there are two tiers of cells and one tier of free nuclei organised in the base of the archegonium. The lower tier of cells is the embryo itself. The next tier forms the suspensor and the tier of nuclei lies freely in the cytoplasm of the archegonium immediately next to the suspensor. The latter develops immediately and elongates quite rapidly, pushing the embryo cells deep into the prothallial tissues. Text-fig 29 shows one of these early stages in longitudinal view.

The suspensor cells, of which there are three or four to each embryo, have elongated to several times their width. Text-fig 30 shows about the same condition, but the cells of the suspensor show a curvature or twist as they advance into the prothallium. It should be noted that there was no evidence of the plug at the base of the archegonium next to the suspensor as reported by Coker (1902) for *Podocarpus* and also by the writer in *Pseudotsuga* (1909). Nothing in the nature of such a modification of the suspensor was found. The suspensor cell seemed to elongate directly into the enveloping tissue. The dissolving of the pro-

teristic appearance of the thick megaspore membrane Feb 6th, 1922

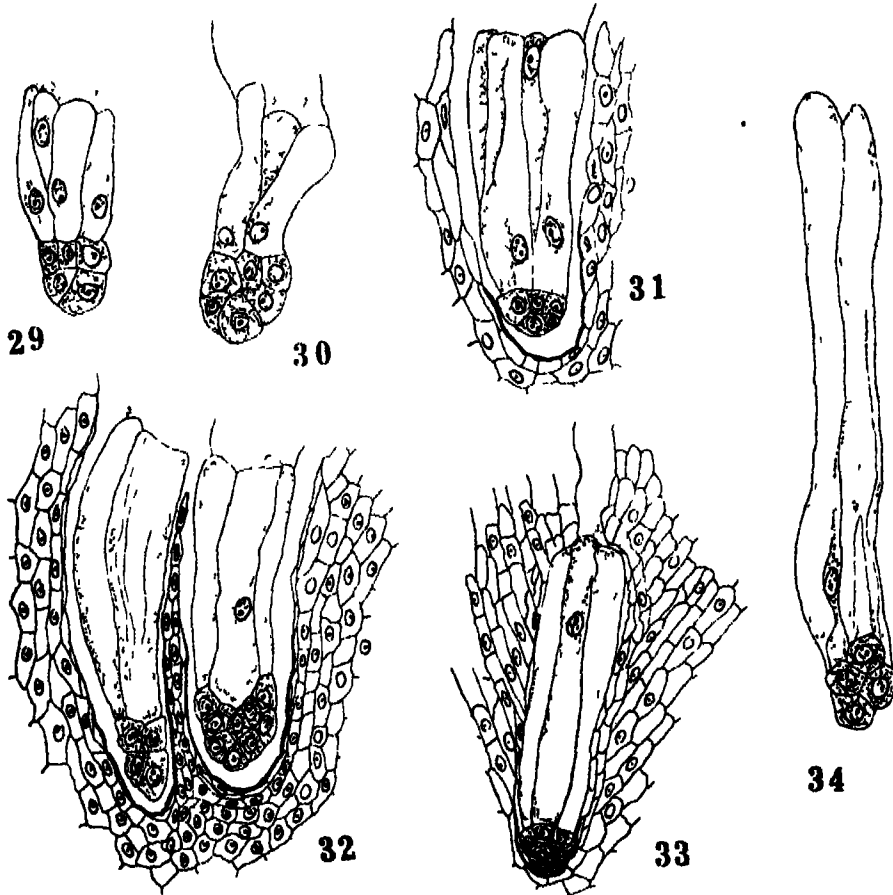
Text-fig 27 —This figure also represents the section through the upper half of the prothallus. The pollen tube, with its contents, is shown. Also the characteristic single group of archegonia enveloped in a common jacket of nourishing cells. The characteristic arrangement of the cells of the prothallus is shown, as also is the megaspore membrane Feb 6th, 1922

Text-fig 28 —This represents a section of a mature archegonium much more highly magnified. Two cells of the neck are shown, as well as the characteristic position of the egg nucleus and the large vacuole. The surrounding jacket cells which appear in two layers are also indicated. Dec 10th, 1922

(Figs 25, 26, 27 x 550, fig 28 x 800)

* Coulter and Land, 1905

thallial cells in touch with the embryo proper was quite evident. There was all the appearance of enzyme action on the disintegrating cells, to make room for and at some time nourish the advancing embryo. I was unable to detect the presence of a cap cell which has been reported for *Podocarpus* and other genera. Text-fig



Text-fig 29 —A longitudinal section to show a young embryo. The suspensor and embryo cells are shown. Feb 19th, 1922

Text-fig 30 —A similar view of the embryo with its suspensor. Feb 19th, 1922

Text-fig 31 —A longitudinal view of an older embryo showing the elongation of the suspensor. The breaking down of the prothallial cells in front of the embryo is also shown. Feb 19th, 1922

Text-fig 32 —Two embryos are here represented. They have developed from different archegonia and appear to be developing simultaneously. Feb 19th, 1922

Text-fig 33 —This represents a slightly older condition of the embryo with the suspensor forcing it deeply into the prothallial tissues. Feb 19th, 1922

Text-fig 34 —An older stage of the same with the great length of the suspensor shown. Feb 27th 1922

(Figs 29-34 x 300)

31 represents the suspensor and the embryo further advanced. The space between the embryo and the disintegrated or digested prothallial cells is quite evident. I was unable to find any branching from the embryo to form embryonal tubes or of more than one embryo from a single archegonium. At this early stage, however, more than one embryo was formed in the endosperm. These, however, were invariably found to have originated in different archegonia. I am therefore of the opinion that polyembryony does not exist other than that described. Text-fig. 32 shows two embryos with their own suspensors advancing together in the endosperm. It is quite clear that these two come from two separate archegonia. It is quite probable that all the archegonia become fertilised and that initial embryos are developed in them. But one of these, as a rule, advances at the expense of the others. Text-fig. 30 shows the embryo slightly older with the suspensor still straight and growing in a median line through the endosperm. Text-fig. 34 is still older, showing the great length of the suspensors. This was the oldest embryo observed.

This brief account of the embryo of *Microcachrys* is by no means complete, but sufficient has been observed to show that it differs in many interesting ways from that of *Podocarpus*.

A very useful summary of our knowledge of the embryo of the Conifers has recently been given by Buchholz (1920). In this a comparative study of the Podocarpaceae has been given.

From this and other investigations (Young, 1907-1910, Robertson, 1904-1907, Thomson, 1909, Kildahl, 1908, Coker, 1902, Burlingame, 1908) it is quite evident that the Podocarpaceae is not a natural class of the Taxineae and our ideas in regard to it require revision. The position of *Microcachrys* in this connection will be discussed by the author in another paper in the near future.

Summary

- 1 There are three wings to the pollen grains and these are symmetrically arranged.
- 2 The mature microspore at the time of pollination contains two prothallial cells, one large centrally situated body-cell, a stalk nucleus and a tube nucleus.
- 3 In the pollen tube the body cell enlarges and, by division, gives rise to two small gametes. These are approximately of equal size and both are probably functional.
- 4 There is a single megaspore mother cell organised.
- 5 After the reduction division four potential megaspores are produced forming an axial row.
- 6 There is a very distinct and definite tapetum formed during megasporogenesis. This is two or three layers of cells thick.
- 7 Only one of the four megaspores germinates. The other three become aborted and finally absorbed. The lowest of the axial row is the functional spore.
- 8 As the functional spore increases in size a large central vacuole is formed which forces the cytoplasm into a parietal position.
- 9 Free nuclear division proceeds and the nuclei are distributed in the parietal cytoplasm.
- 10 Endosperm formation takes place by the "alveoli" method. That is, primary prothallial cells are formed in the parietal cytoplasm which grow out into

- the central vacuole in the form of long tubes. These eventually close in on the vacuolar space and then regular cellular tissue follows
- 11 A very distinct and thick suberised megaspore membrane is formed quite as thick as in the Abietineae
 - 12 The archegonia, may be five or six in number, form a single group at the apex of the prothallus. They have a common jacket and a common archegonial chamber. There are four neck cells in one tier
 - 13 Fertilisation takes place by the contents of the pollen tubes being discharged into the archegonial chamber
 - 14 The embryo is organised from three tiers of nuclei in the base of the archegonia. The middle tier forms the suspensors which carry the embryo into the endosperm

In conclusion I desire to express my thanks to my Laboratory assistant, Mr O D Evans, for help in the collection and preparation of material

I also desire to express my indebtedness to the University of Sydney for a grant of money from the McCaughey Research Fund, which helped to defray the expenses in the collection of specimens in Tasmania

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EXPLANATION OF PLATES XV. -XVI

Plate xv

Microcachrys tetragona, showing general habit of plant with microspore cones (natural size)

Plate xvi.

Microcachrys tetragona Branches showing megaspore cones (x 9.)

STUDIES IN SYMBIOSIS

IV THE ROOT-NODULES OF *CASUARINA CUNNINGHAMIANA* AND THEIR
PHYSIOLOGICAL SIGNIFICANCE

By J. McLUCKIE, M.A., D.Sc., Lecturer in Plant Physiology, University of Sydney.

(Sixteen Text-figures)

[Read 30th May, 1923]

Introduction

Since the discovery by Hellriegel and Wilfaith in 1888, that the root-nodules of the Leguminosae are able to "fix" or assimilate atmospheric-nitrogen, much research has been conducted, not only upon the various genera of the Leguminosae, but also upon other root-nodule possessing types, such as the *Cycadales*, *Alnus*, *Eleagnus*, *Myrica Gale* and *Podocarpus*. Early investigators of the subject did not find bacteria in the nodules, and believed that the fungal hyphae, which commonly occur in older nodules, constitute a mycorrhiza. In *Podocarpus*, Nobbe and Hiltner (1899) proved indirectly by experiments that the root-nodules were active nitrogen-fixing structures, but they and others (e.g., Shibata, 1902) believed this property to be due to what appeared to be fungal hyphae in the cortical cells of the nodules. It was not known that the active nitrogen-fixing organisms are bacteria which migrate from cell to cell in zoogloea threads bearing certain resemblance to fungal hyphae.

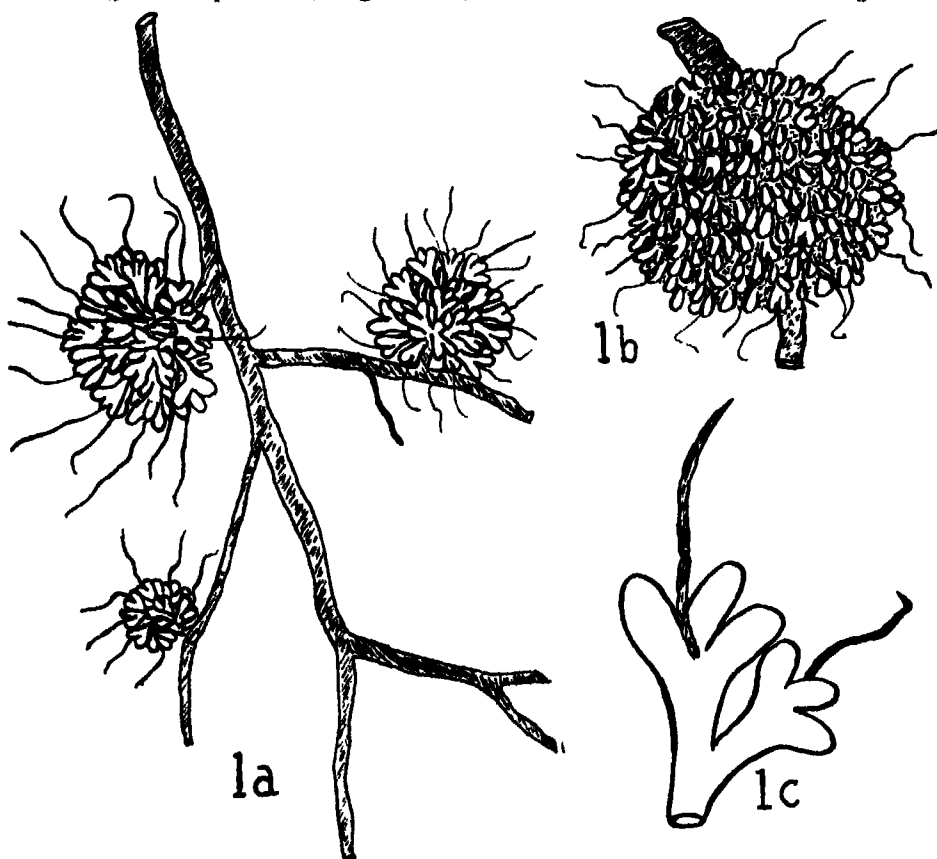
In 1896 Hiltner demonstrated the presence of bacteria in the root-nodules of *Alnus* and *Eleagnus*, and in a series of experiments proved (1) that plants devoid of root-nodules could not thrive in a soil poor in nitrogen, (2) that such starved plants thrived when the soil was inoculated with the organisms from the nodules, and (3) that the nodule-formation increased with the poverty of the soil in available nitrogen.

In 1904, Lillie investigated the root-nodules of *Cycas* and discovered bacteria within them. Bottomley (1907) isolated these bacteria, and proved them capable of nitrogen-fixation. Bottomley (1912) studied the development and structure of the root-nodules of *Myrica Gale*, and isolated *Pseudomonas radicumicola* from them. Spratt (1912) performed similar researches upon *Alnus* and *Eleagnus*, and claims that *Pseudomonas radicumicola* occurs in these nodules also, and that it is polymorphic. McLuckie (1922) investigated the tubercles of *Macrosama spiralis* and isolated bacteria from them and proved that they were nitrogen-fixing forms. In the present communication, the author gives the result of his investigations of the root-nodules of *Casuarina Cunninghamiana*, a form which has not hitherto been described in detail. Darnell-Smith in a brief note mentions

their occurrence and that they are inhabited by bacteria, but no detailed account of the nodules is given

The Root-nodules

Casuarina Cunninghamiana is a species which commonly occurs along the banks of creeks. The material for this investigation was obtained along the banks of the Nepean River near Penrith, N S W. The great majority of the roots of this plant possess nodules of varying sizes, some being quite small and branched once or twice, others being profusely branched, 50-60 mm in diameter, and larger than any other root-nodules yet recorded. The youngest nodules occur as small lateral growths upon the youngest roots, and are from 3 mm to 5 mm long and



Text-fig 1a—Roots of *Casuarina Cunninghamiana* (Miq) bearing nodules of various sizes ($\times \frac{1}{2}$)

Text-fig. 1b—Single large coralloid nodule showing the rootlets emerging from the cluster ($\times \frac{1}{2}$)

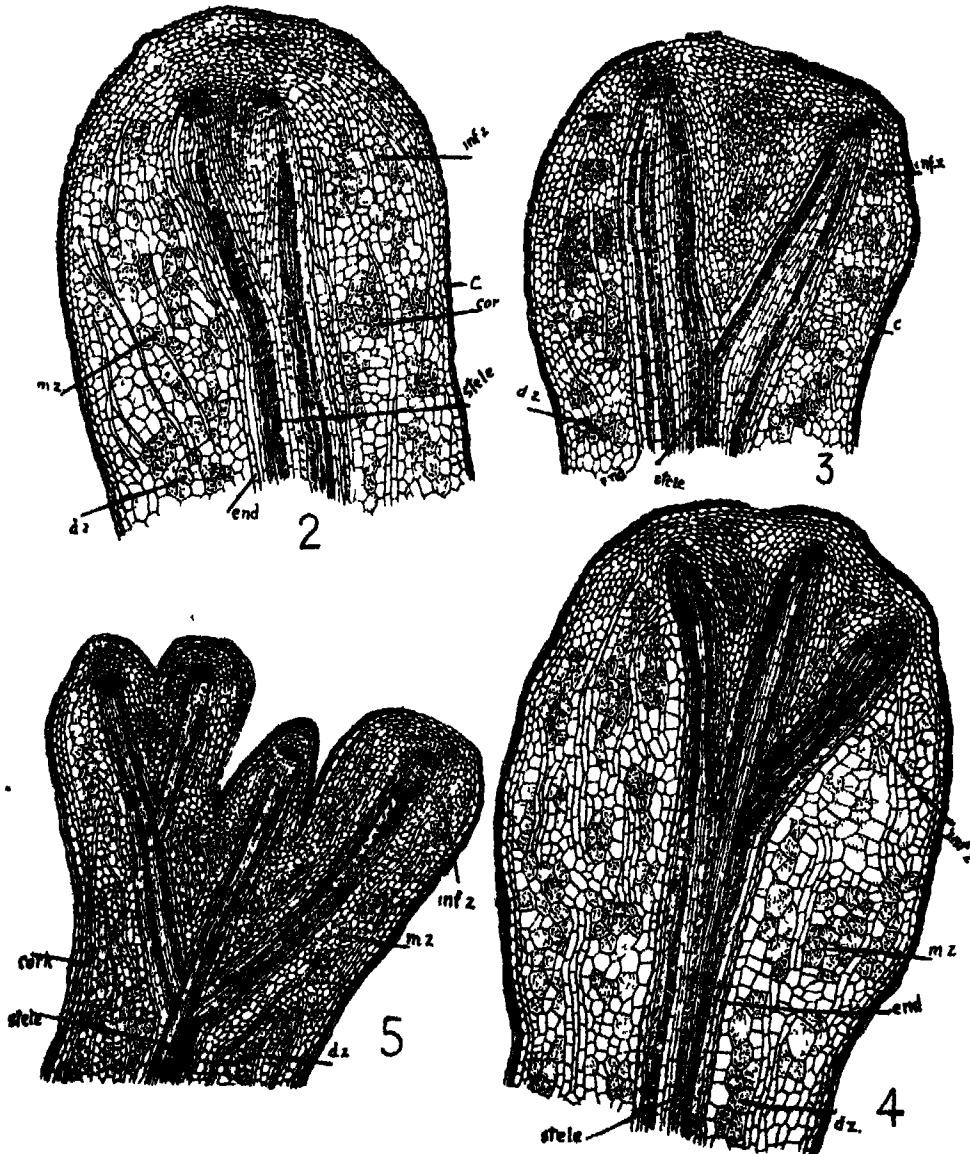
Text-fig 1c—Portion of a coralloid mass showing method of branching ($\times 2$)

1-2 mm in diameter. They bear a general resemblance to the young nodules of *Macrozamia* or *Cycas* at this stage. Branching begins early in the primary ne

dules, and from the meristematic cells at the apex, three or four groups are formed, which become the apical meristems of the branches. These again branch after a short growth phase, and in a comparatively short time a remarkably large "cluster" nodule is formed (Text-figs 1a, 1b). The nodules are perennial and are covered externally with several thin layers of cork. In nature many of the nodules are exposed or lie very close to the surface of the soil, as in *Macrosamnia* and *Cycas*. The general appearance of the mature coralloid nodules is similar to that of the root-nodule of *Myrica Gale* described by Bottomley. As seen in Text-figs 1a, 1b, numerous short thin rootlets project from the nodule, but die off terminally. The tips of the nodular branches are rather whitish, while the rest of the structure is protected by cork. Text-fig 1c, shows a small portion of a large coralloid nodule and incidentally the branching which is typical of this form.

For anatomical work the material was fixed either in 1% chromoacetic acid or in 10% acetic alcohol. The stains found most useful were Gentian Violet and Safranin, Gentian Violet, Lugol's Iodine and Safranin, and Gram's stain. Median longitudinal sections of the nodules are shown in Text-figs 2, 3, 4, and 5, a central stele is plainly demarcated, surrounded by an endodermis containing a tannin deposit. A clearly defined meristematic zone is seen at the apex, and in Text-fig 2, it has bifurcated. In Text-figs 3, 4, and 5 different stages in the branching of the nodule may be seen. The meristematic zone of cells generally divides into four fairly distinct groups, namely, a central mass which continues the growth of the axis of the mother root, and three, more or less laterally developing masses which form the branches of the primary nodule. In a longitudinal median section, as a rule, only three of these groups and the stelar structure passing into them are seen. The apical part of each nodular branch becomes considerably swollen. Beyond the apical meristem groups, several layers of small cells are formed, which, however, cannot be recognised as a definite root-cap, and which merge imperceptibly into the cortical tissues behind the apex. In young branches, the extreme tip of the nodule is not covered with cork, but the apex of all the older nodules is so protected, and the surface becomes quite hard and brittle. The apical zone of meristematic cells, or their immediate derivatives, are free from bacterial infection. Behind the meristematic zone three distinct zones are defined, namely (a) the cork (c), (b) the cortex (cor), and (c) the stele. In the cortex, groups of bacterial cells occur, these infected cells are large, thin-walled, and densely cytoplasmic. In sections of living nodules the bacterial cells are differentiated by their yellowish contents and in fixed material by the staining of the bacteria. In the cortical cells of the nodule three definite regions may be observed, namely, (a) the zone of infection (z inf), (b) the mature zone of bacterial masses (m z), (c) the degenerating zone where bacterial digestion occurs (d z). Text-figures 6, 7, 8, 9, show various stages of infection of the younger cortical cells. A few or numbers of infection threads may be seen passing from cell to cell, and coiling in the vicinity of the nucleus. These threads contain rod-shaped bacteria, and have a rather slimy consistency. They are of irregular diameter. In some cells, especially those just infected, these threads are very thin, but in slightly older cells, the bacterial threads are thicker and more numerous. The infection of a cell by the bacteria leads to a considerable enlargement of the cell so that, apart from the difference in their contents, they are readily distinguished from uninfected cells by their size. A very important feature of the bacterial zone is the large intercellular spaces providing for gaseous circulation. These spaces communicate with the atmosphere through the irregularities and cracks in the superficial lining of cork cells, or through the epidermal

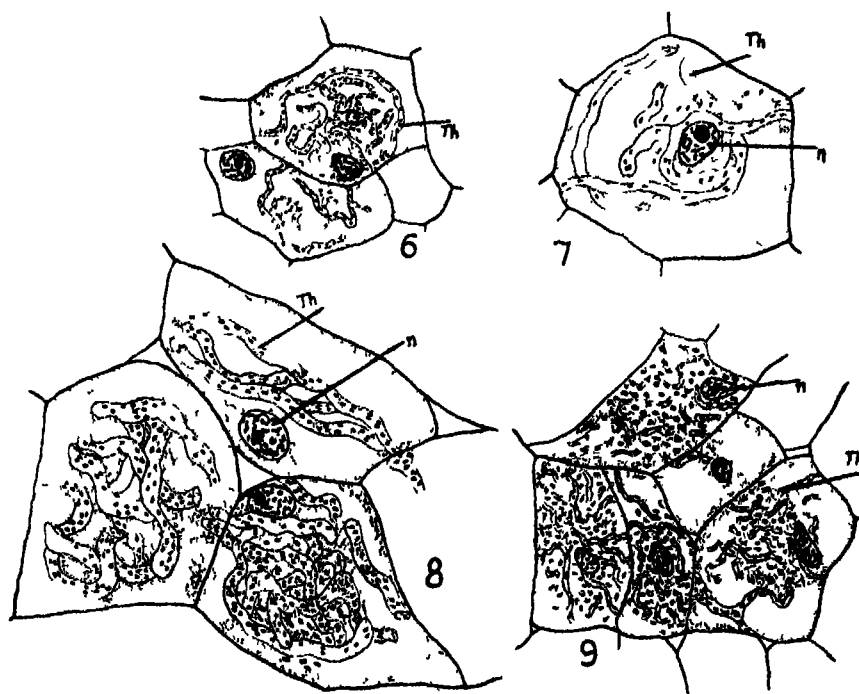
cells near the apex. The bacterial cells are divided into groups by longitudinally-arranged fibres, or thickened parenchymatous cells, which frequently take an irregular course in the midst of the thin-walled tissue. These points are clearly



Text-figs 2, 3, 4, 5—Longitudinal sections of apex of nodule showing the branching, the corky covering (c), the cortex (cor) inhabited with bacteria, the stele. The infected zone (inf z) is behind the apex, the mature zone (m z) further back, and the zone where bacterial degeneration occurs (dz) is the older part of the nodule (x 33)

brought out in the Text-figures 2, 3, 4, 5, and 10. In old bacterial cells, the threads can seldom be distinguished, and the bacteria appear to be more or less uniformly distributed throughout the cell-cavity (Text-figs 11 and 12).

Near the base, i.e., in the older part of each nodular branch, the bacterial cells undergo a change. Many of the bacteria either leave these cells, or undergo degeneration into bacteroids. They swell up, lose their contents, and disintegrate. This degeneration of active bacteria into inactive bacteroids is apparently a natural event, as in every culture of the bacteria upon nutritive turnip or glucose agar, or in liquid media as demonstrated later, many bacteria become



Text-figs 6, 7, 8, 9—Cells of infection zone (inf z in previous figures) showing the thin gelatinous threads containing the bacteria and spreading from cell to cell (x 600)

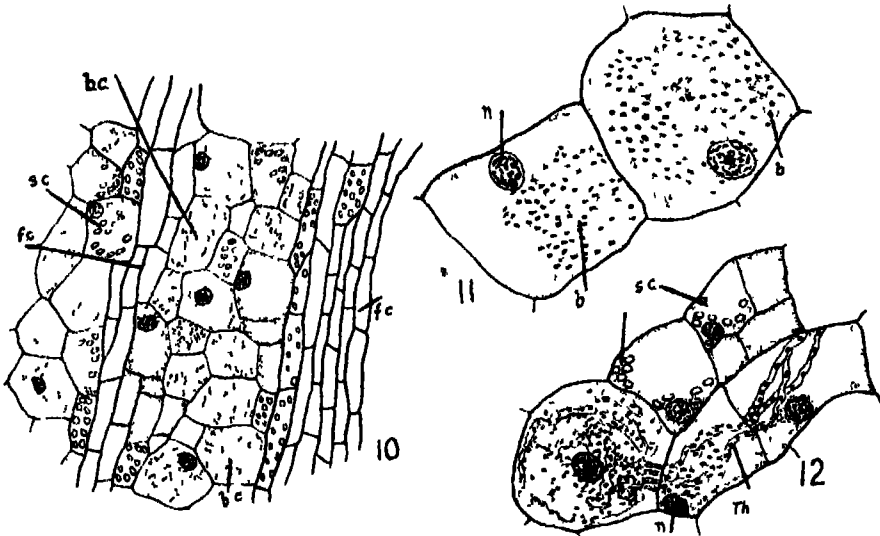
quite inactive and enlarged although the culture conditions, such as food supply and temperature, were constant. Throughout the cortical region of the nodules there is abundance of food.

In the nodules of *Podocarpus spinulosa*, I have observed fungal hyphae in the older cortical cells, previously infected by bacteria, but in *Casuarina* I have not seen fungal hyphae in the tissues.

In infected cells, the nucleus does not appear to be stimulated to mitotic activity, as is frequently the case in fungal-infected cells, but the chromatin aggregates from the finely reticulated condition to a coarse granular state. Frequently two or three nucleoli appear in the nucleus, and in a few cells two nuclei were observed. In many of the old cells containing the bacteroids, one or more,

globular yellowish masses of an oily nature were observed but no starch. Probably these masses are the residues of digested bacteroids.

Text-fig 13 shows a transverse section of a nodule, through the bacterial zone, the cork, cortex, and stelar zones are readily distinguished. The stele is tetrarch. Surrounding the stele is the clearly defined endodermis. This layer and others surrounding it contain a quantity of tannin.



Text-fig 10 A small portion of the cortex from a longitudinal section of nodule showing the bacterial cells (bc), the starch cells (sc) and the fibrous cells (fc) (x 167)

Text-figs 11, 12 —Old cells of the cortex showing dense masses of bacteria, in such a stage the threads can be seen only with difficulty, sc starch cells (x 600)

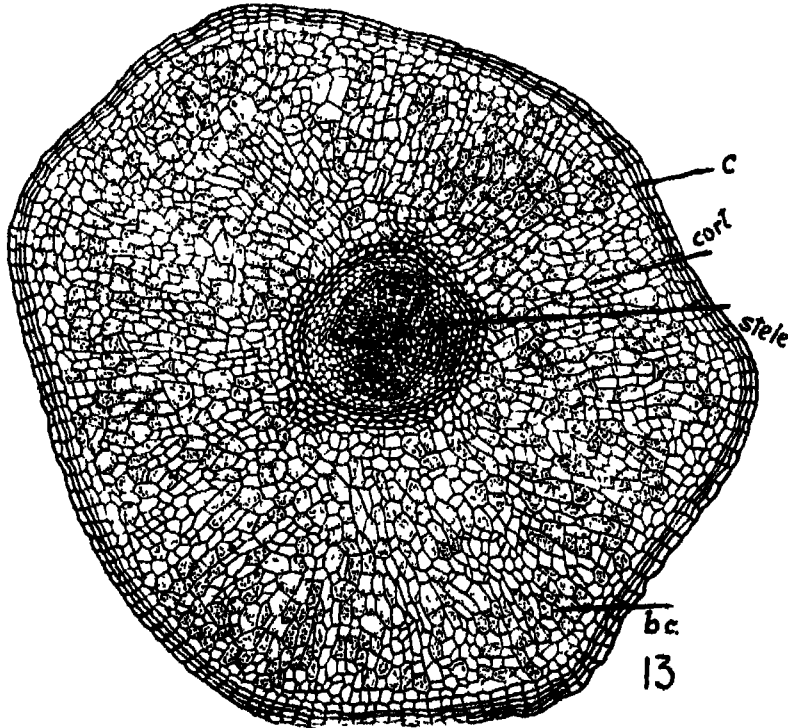
The cortex is composed of enlarged parenchyma cells containing bacteria, prosenchymatous or fibrous cells with thickened walls, and thin-walled cells containing food such as starch. In cells showing the infection threads considerable numbers of small starch grains are observed, but these later disappear, and are not present in the cells containing bacteroids. Numerous cells containing a brownish red tannin deposit occur throughout the cortex.

Nodule a modified lateral root

The coralloid nodule is an aggregation of short branches derived from a primary modified lateral root whose normal development is inhibited by the bacterial infection.

The bacteria gain access to the cortical tissues of the main root through the root-hairs. The young lateral root is frequently infected soon after its inception, by the migration of bacteria from the cortical cells into its periblem cells. This infection retards the normal elongation of the root, but its diameter increases at first by the enlargement of the infected cells and the normal growth of the stelar

tissue, but later by the meristematic activity of a phellogen which superposes corky layers upon the older parts of the root and increases the cortical tissue within. The nodule, therefore, starts as a modified lateral root. The presence of bacteria just behind the meristematic zone appears to stimulate vigorous and frequent branching such as we do not find in the normal root branching. There is no root-cap upon the nodule, but some of the apical tissue of the original primary root-nodule is continuous over the secondary branches. This is seen in Text-fig 5



Text-fig 13 -- T.S. of nodule showing stele, cortex and cork, and the distribution of the bacterial cells (x 50)

The central group of meristematic cells grows forward into a thin rootlet which soon dies off at the free end and becomes thickly covered with cork.

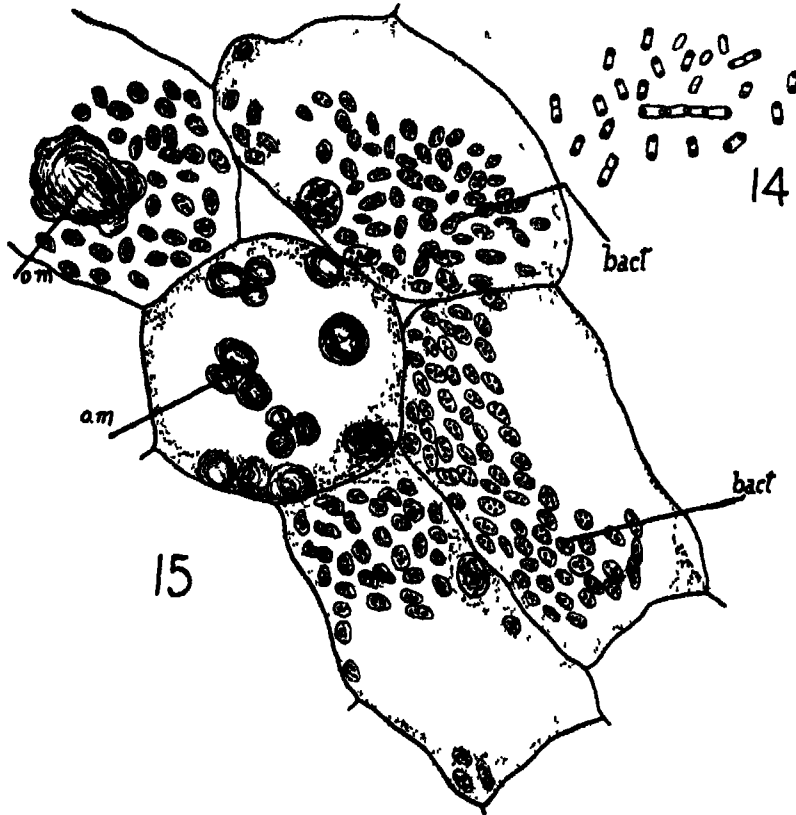
Around the primary nodule, three lateral secondary nodules are developed, while the axis of the original nodule continues to grow forward as a thin fibrous root. Each secondary nodule enlarges and subsequently forms two or three tertiary nodules, leaving the main axis, as before, to grow out into a thin rootlet. In this manner a large coralloid mass is soon formed.

The nodule bacteria

Young nodules were sterilised carefully by immersing several times for a minute in a sterilising fluid employed by Harrison and Barlow when investigating the nodules of the Leguminosae, and washing after each immersion, in distilled

water. The composition of the fluid employed is as follows. Distilled water 500 c.c., Mercuric chloride 1 gram, Hydrochloric acid 25 cc. After careful sterilisation and washing, one of the nodules was crushed upon a slide, the smear was dried and stained in Carbol Fuchsin, and in Gentian Violet, Lugol's Iodine and Safranin. The bacteria proved to be small rod-shaped forms, bearing a very close resemblance to the organisms in *Podocarpus spinulosa*.

When stained with Kiskalt's amyli gram preparation, the bacteria were readily decolorised with ethyl alcohol, but the gentian violet is retained with the amyli alcohol. From this fact, and the general form and life-history of the bacteria I am inclined to regard the organism of *Casuarina* as a species of *Pseudomonas*.



Text-fig. 14 —The active rod-shaped bacteria (x 1400)

Text-fig. 15 —A group of cortical cells from the degenerating zone (dz of Figs 2, 3, 4, 5) showing the bacteroids (b) and the only masses (o.m.) (x 1400)

Pure cultures of the organism were made by transferring some of the expressed contents of sterilised nodules by means of a sterile platinum needle to sterilised turnip agar or glucose agar in test tubes and in petrie dishes. The tubes and dishes were incubated at a temperature of 26.5°C and in the course of 24 to 48 hours small vigorously growing colonies of the bacteria were pro-

duced The colonies were generally roundish, raised, exceedingly viscous and shining on the surface (Text-fig 16) They enlarged very rapidly By means of a platinum needle some of the bacteria were transferred to a clear sterilised glass slide, and on the smear being dried and stained the typical rod-shaped bacteria of the living nodules were observed Text-fig. 14 shows the typical character of the bacteria of *Casuarina Cunninghamiana*, and it will readily be observed that they are remarkably similar to those of *Podocarpus spinulosa*, and of *Alnus* (as figured by Spratt 1912)

Parts of old nodules were similarly sterilised and their contents expressed upon a clean sterilised slide and stained In this case, very few of the typical



Text-fig 16 —Photographs of bacterial cultures from *Casuarina* nodules

short rods were found, but numerous oval, enlarged, granulated individuals were observed Many of these contain granular bodies, while others are empty. These structures are probably bacteroids derived by degeneration from the active rod forms Text-fig 15 shows a few cells of the older part of the nodule containing the typical bacteroids of this form

Nitrogen fixation by the bacteria.

The culture solution for the purpose of this estimation had the following constitution —Saccharose 10 grams, Acid potassium phosphate 5 grams, Magnesium sulphate 0.5 grams, Distilled water 1000 cc, neutralised with sodium hydrate Each of five 500 cc flasks, A1, A2, containing 100 cc. of this

solution was autoclaved for 20 minutes at a temperature of 140°C, cooled and inoculated with the bacteria from a young culture upon turnip agar, by means of a platinum needle. Two flasks B1 and B2, each containing 100 cc of the nutrient solution were inoculated and autoclaved in the same way. These constitute controls.

All flasks were then incubated at a temperature of 26.5°C for 14 days, when a Kjeldahl estimation of the nitrogen content of the flasks was made. The following results were obtained:

In the flasks B1 and B2, in which the organisms were killed by autoclaving, only a slight trace of nitrogen was found to be present.

In flasks A1, A2, A3, A4, A5, the nitrogen content was respectively 5.45, 5.1, 5.82, 5.32, and 5.65 mg. The average per flask is 5.468 mg for 14 days, or average fixation of nitrogen amounting to 0.3906 mg per day. As the flasks at first contained no combined nitrogen excepting that introduced during inoculation with the bacteria, which proved, in the controls, to be a mere trace, the bacteria introduced to the culture solution must have "fixed" or assimilated the free atmospheric nitrogen of the flask.

In the course of these experiments, it was observed that nitrogen-fixation was more active in large flasks in which the nutritive fluid could be spread out in a thin layer. When flasks of 300 cc capacity were employed, the nitrogen fixation per day was only 0.32 mg. The temperature found to be most suitable was 26.5°C.

It therefore appears that the nodules of *Casuarina Cunninghamiana* contain bacteria which possess the power of fixing free atmospheric nitrogen, and, from the analogy of the *Leguminosae*, that the plant benefits by the presence of the root-nodules.

Nutrition of the bacteria

When the bacteria are grown in a nutritive culture solution they multiply rapidly, imparting a cloudy appearance to the solution. During metabolism they assimilate free nitrogen from the flask and convert it into an organic state which is availed of by the host-plant as in the *Leguminosae*. But the bacteria require carbohydrate during this process. Experiments show that they develop just as actively in the presence of glucose or maltose, or saccharose, while their activity is inhibited if saccharose or glucose or maltose is omitted from the solution. They cannot obtain their carbon from the CO₂ of the flask. In the bacterial cells of the root-nodules, the bacteria no doubt obtain supplies of carbohydrates manufactured by the host. A considerable amount of starch may be observed in cells which are free of bacteria or in the early stages of infection, but in mature bacterial cells, when the bacteria come to occupy the whole cavity of the cell, no trace of starch can be found. It is probable, however, that it is transformed to sugar (maltose) and as such is absorbed by the bacteria.

Although the nodules of *Casuarina* are perennial and protected with cork, sooner or later portions of the coralloid mass begin to decay and the bacteria or bacteroids which they contain are given up to the soil. By this means the soil becomes enriched with combined nitrogen after the manner of the *Leguminosae*.

Summary

1. The nodules on the root of *Casuarina Cunninghamiana* are modified lateral roots whose normal development is modified by bacterial infection.

- 2 The nodules branch profusely, three or four branches being formed from the apical meristem of the primary nodules. By the similar branching of these secondary nodules and their derivatives, a large "coralloid" mass of nodules is formed which may attain very considerable dimensions.
- 3 From the coralloid mass, slender fibrous rootlets radiate, these die off terminally.
- 4 In each nodule there is a covering of cork, a comparatively wide cortex composed of large parenchymatous cells containing bacteria, and longitudinal rows of fibrous cells, and a central stele surrounded by an endodermis.
- 5 The meristematic tissue does not contain bacteria.
- 6 In each nodule there is (1) a region near the apex, behind the meristem, containing infection threads of the bacteria, (2) the extensive zone of bacterial cells divided by the fibrous cells into groups, and (3) the basal zone which contains the older bacterial cells in which the bacteria are inactive and converted to "bacteroids."
- 7 The nodule has no root-cap, but owing to the peculiar method of growth some of the tissue of the primary nodule covers the apex of its derivative branches.
- 8 The nodules are perennial and, with the exception of a small apical portion on the youngest, are completely covered with cork.
- 9 The bacteria were isolated in pure nutritive agar cultures and examination revealed that they were small rod-shaped forms somewhat closely resembling *Pseudomonas radicicola* which occurs in leguminous nodules.
- 10 The rod form becomes transformed into an oval bacteroid, which may undergo digestion by the cell-cytoplasm.
- 11 The bacteria were grown in liquid cultures free of combined nitrogen, and containing carbohydrate. Kjeldahl estimates of the nitrogen content of the flask demonstrated that an average of 5.468 mg of N were "fixed" in 14 days per flask, or 3906 mg per day.
- 12 Saccharose, maltose and glucose proved of practically equal nutritive value to the bacteria, which are unable to use the CO₂ of the air in the flask as a source of carbon.

My sincere thanks are due to Professor Lawson for his kindly advice and criticism, and to Mr. O. D. Evans for his trouble in finding some of the material.
Botany School, Sydney, January 25th, 1923.

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NOTES ON FRESHWATER ALGAE *

By the late G I PLAYFAIR

(Thirty Text-figures)

{ Read 27th June, 1923 }

1—*Chlamydomonas globosa* Snow, and allied forms

It was during the summer of 1918 that I obtained a pure culture of this species under rather curious and interesting circumstances. A small enamelled-iron pie-dish, with scraps of fish adhering to its sides, had got adrift on an almost horizontal corrugated iron roof situated in the very heart of the business portion of Lismore (N S W), where it was exposed to the full blaze of the sun throughout the greater part of the day. The month of March (summer) opening with alternate heavy rain and hot sunshine, on the 3rd the dish was noted to be full of rainwater, on the 10th the water showed a yellow tint which next day had deepened to pale yellow-green. Besides, there was a certain amount of yellow-green sediment at the bottom of the dish, and scum on the surface of the water.

An examination made on the 11th with a 1-12 homog imm objective revealed a culture of *Chlamydomonas globosa* Snow, easily recognized by its minute size, spherical shape and general delicacy of appearance. The cells were commonly of diam. $4-8\mu$, some motile, some non-motile, very transparent, the chloroplast very delicate and homogeneous, a few small amylaceous granules round the central core of the cell. A few cells were larger, diam $10-12\mu$. Pyrenoid distinct, also stigma midway between the poles, cell-membrane very thin, invisible.

Here and there spherical mother-cells (diam c 25μ), with 4 autospores of diam 7μ arranged tetrahedrally, revealed the method by which the rapid growth of the culture had been attained.

Chlamydomonas globosa was first noted in the plankton of Lake Erie and has generally been considered a distinctively plankton form. However I find it quite common after rain in all sorts of places, e.g., roadside puddles, small pools, duck-ponds, swamps, and even enmeshed in filamentous tufts on grass lands or in fungoid growths on dead sticks in standing water. It is not any particular habitat that conduces to the development of plankton forms but an abundant

[*The manuscript of this paper was completed by the author just before his death in October, 1922. The drawings, however, were not complete, only a number of rough sketches having been prepared. The figures illustrating the paper have been drawn from those rough sketches—Ed.]

supply of water, either from the natural environment, or from rain, or from surface drainage

The occurrence of a culture in quantity in a domestic cooking utensil which had never previously held even garden soil and which was far removed from any source of infection, shows how wind-blown the resting cells of the freshwater algae may be

Var *MACULATA*, n var

Forma membranâ tenuissimâ, chloroplastidibus maculatis vel serobiculis notatis Cetera ut in forma typica Specimina parva granulis (ut videtur) aspera Diam 10-12, vel 13-16 μ

Intermingled with the type were cells showing very distinctly a spotted or pitted chloroplast The cell-wall being very delicate, this caused the smaller specimens to appear granulate

CHLAMYDOMONAS OVATA Dangeard

Mem sui les Chlamyd, p 147, f 17, cf Wille, Gatt Chlamydomonas in Algol Notizen, ix-xiv, 1903, p 133, T iv, f 3

Var *PULCHRA*, n var

Cellulae lenticulares, utroque polo subacutae, lateribus aequaliter arcuatis Long 18, lat 9 μ

A still later examination of the culture revealed no new development, but brought to light this beautiful and interesting form which seems to be too near Dangeard's *Chl ovata* to be separated from it

Cells broadly lenticular in face view, with subacute ends and evenly arched sides, stigma not noted From the shape of the mother-cell it would appear that this is a form produced by longitudinal self-division of a spherical cell into 4 parts In Dangeard's original figure (reproduced by Wille, *op cit*) the chloroplast seems to be disarranged and to have shifted round to the side of the cell, probably with a view to a *transverse* division There would thus be produced 2 spherical cells on a smaller scale Self-division in two directions is common enough in the freshwater algae generally

No dimensions are given for *Chl ovata*, but the figures work out at - Long 10, lat 8-8 $\frac{1}{2}$ μ

CHLAMYDOMONAS SNOWII Printz

Skr Vidensk-Selsk i Kristiania, Mat.-Naturv KJ, 1913 (1914), No 6, p 18

Along with *Chl globosa*, Miss Snow found and described (Bull US Fish Comm, 1903, 22, p 388, Pl 1) another species, viz *Chl communis* Snow That name being preoccupied, the form has been renamed as above The latter, however, is really an oval or oblong variation of *Chl globosa* I find them always together In the above natural culture this form was present in quantity, dimensions long 7-10, lat. 5-7 μ , stigma a little above the centre and the cells oblong rather than oval

It is quite the usual thing for a spherical species of *Chlamydomonas* to have an oval or oblong variation. Thus of *Chl globulosa* Perty as commonly found here (diam 14-25 μ) Wille, *op. cit* says "Die Zellwand der Zoospore ist kugelförmig oder schwach ellipsoidisch" . . . I have myself figured that of *Chl monadina* (Austr. Frw Phytopl These Proceedings, 1917, Pl lvi, f 16). Compare also

Chl maculata Plavt (These Proceedings, 1918, Pl iv, t 15, l 19 and f 18), the last being obviously intermediate between the other two

An ovate form of this type is described below

Chlamydomonas taurangensis, n sp (*vide infra*) was present also

11.—Examination of certain green fluffy growths

(On February 13th, 1920 (summer) after heavy rains, my attention was drawn to certain green fluffy tufts adhering to grass blades in rainwater pools on a piece of meadow land previously quite dry. Minute observation of such growths often brings to light new, rare or interesting forms of life, besides affording much useful information

a—In this case the green tufts proved to have as a foundation a mass of infantile filaments of *Oedogonium* sp so unformed as to be hardly recognizable, except by their characteristic flecked chloroplasts and a slight enlargement of one end of certain cells

The *Oedogonium* cells began to form zoospores. One or two cells near the end of a filament twisted at right angles, the filament broke across and the contents of the cell gradually drew out. Occasionally the inner portion of the cytoplasm lagged behind but was later absorbed. There was no fusion of the cell-contents, they remained disposed exactly as in the cell with a small central nucleus plainly visible and a small pyrenoid at each end. In general, the shape of the zoospore is more or less oval or long ovate, but a cylindrical form was also noted. In front it is produced into a large ciliated papilla of clear homogeneous protoplasm. No stigma, no pulsating vesicle nor chlamydomonadine structure observed. Size of zoospores—long c 30, lat 15 μ . They soon settled down to form new filaments

In a gathering of *Cladophora* sp made at Tauranga, N Z, on January 3rd, 1922, the subsequent development of these zoospores was noted. They form *Characiopsis*-like resting cells, from the apex of which young *Oedogonium* filaments push out. Dimensions of resting cells—long 20-40, lat 8-18 μ , they are more or less oval, adhesive disc distinct, chloroplasts finely granular, sometimes obscurely divided into four parts, no pyrenoids visible. When devoid of contents they cannot be distinguished from *Characiopsis*.

b—Entwined among the *Oedogonium* filaments, *Leptothrix* threads in quantities were busily breaking up into *Spirillum volutans*.

c—(*Chlamydomonas globosa*, vegetative cells in quantity attached to an almost invisible hyaline membrane, cells rapidly becoming motile, diam 3-10 μ , globular. Var *maculata* mihl also present, as well as *Chl Snowii* Printz (*see above*), dimensions—long 10, lat 6 μ , with huge pyrenoid (diam 3 μ), half the breadth of the cell

d—*CHLAMYDOMONAS MUCICOLA* Schmidle

Algenflora d Schwarzwaldes u d Oberrheins, vi. 1897, p 17-19 T ii, fig 4-8 (*f* Wille Gatt Chlamyd (Alg Notizen. xi, p 136, T iv, fig 6)

Var ROTUNDATA, n var

Forma cellulis sursum rotundatis, papillâ nullâ; stigmatè distincto, paullo supra mediam, pyrenoidi maximâ ad latus dispositâ. Long 9, lat 4 $\frac{1}{2}$ μ .

Differs from the type in being rounded above, not acuminate, and without the apical papilla. A stigma too is distinctly visible a little above the middle and the pyrenoid very large, quite half the width of the cell. It does not lie in

the lumen of the cell (though it may appear to do so when the latter is in a certain position) but is placed laterally. This *Chlamydomonas*, which I now observed for the first time, was present in quantity, cells both motile and non-motile. The body is rather irregular in outline, varying from elliptic to long ovate, often with unequally arched sides, probably the result of longitudinal self-division. Chloroplast bag-shaped, with pyrenoid median and lateral, and the nucleus at the hinder end of the cell. Schmidle gives as dimensions—long 6-8, lat 3-4 μ .

A very similar species is *Chl. Kutenskowi* Goroshankin (Morph u System d Chlamyd., 1891, p 117, T n, fig 9-13) which has a thin laminar chloroplast and distinct median stigma, but is double the size. I hesitated for long whether or not to place our form under Goroshankin's type as the latter has priority. I was only decided by the dimensions.

e—*Spondylomorpha quaternaria* var *rostratum* Playf. (These Proceedings, 1918, p 526, Pl lvi, fig 16, 17) Minute 8-celled coenobia noted, only 16 μ in diameter.

f—*Euglena pisciformis* var *granulosa*, n var. — (See Note xix p 223)

iii—*Ulothrix quaternaria*, n sp. (Text-figs 1-5)

Ulothrix filaments longam massam cinereum saturate viridem formantibus. Fila latitudine 7-9 (rarius 10-11) μ ad septa haud constricta, apicibus acute conicis, cellulis plus minus quadratis (7-12 μ alt.) diametro 1-1 $\frac{1}{2}$ plo longioribus, vel cylindraceis (17-28 μ alt.) diametro 2-4 plo longioribus. Chloroplastides parietales, pyrenoidibus 2-4 (rarius 6) transverse geminatis dispositis (plerumque 4 per quadratum ordinatis). Zoosporae globosae ovatae, vel fusiformes, long 8-21, lat 7-10 μ , flagellis 4.

FORMA angustissima, filis latitudine 4 μ , cellulis cylindraceis (10-30 μ alt.) diametro 2 $\frac{1}{2}$ -6 plo longioribus, polos aduersus pyrenoidibus singulis.

This plant I noted first in January, 1918 (summer) forming deep green silky skeins in a cement water table near the Post Office, Lahore. There were yards of it, and it could be taken up by the handful, the water was quite warm to the touch. The filaments were 8 μ in diameter (rarely 10 μ) not constricted at the septa, cells varying from quadrate (12-15 μ alt.) to cylindrical (generally 21-25 μ alt.) 2 $\frac{1}{2}$ -3 times longer than the diameter. In general outline it very much resembled *Microspora stagnorum* (Kütz.) Lagerh. in Hazen, *Ulothrix* and *Chaetoph* of the U.S., Pl 24, f 13. Besides it answered very well to the description of *Ulothrix subtilis* Kütz. (in Rabenh. in Rabenh. in Rabenh., Fl Eur Alg., iii, p 365) now considered a species of *Stichococcus*. However, on mashing up some filaments on a glass slip, no H-pieces showed in the broken cells which also refused to dissociate at the septa as in *Stichococcus*. The plant therefore seemed to be a species of *Ulothrix*. Apart from the size and shape of the cells its chief characteristic is the formation of a large number of pyrenoids, generally 4, arranged in a more or less regular square near the centre of the cell.

Soon afterwards I found it again in company with a lemon-yellow slime fungus scraped off the wooden supports of a tank and almost aerial in its surroundings, being merely wetted now and then with rain water. The filaments were again 8 μ broad, cells alt 14-16 μ , 2 pyrenoids in each cell placed transversely and becoming 4 by division. This formation of pyrenoids would therefore appear to be a specific character.

A little later the plant came to hand in quantity from a cement water-table in Carrington Street in the waste water from the Electric Power House. Filaments then 7.9μ broad with acutely-pointed conical tips were noted. Cells either quadrate (alt 7.12μ) or cylindrical (alt 17.28μ), pyrenoids as before.

This sample being brought in late in the evening, was left uncovered on the lid of a tin all night. Next morning by 9 a.m. the exposed portion was actively engaged in forming zoospores. A thin-walled globose cyst developed in the cell and burst through the cell-wall on one side. Within this the zoospore formed (Text-fig 1) and later broke forth, but often the cell-contents simply forced a way at once through the cell-wall and issued as a zoospore. The process took 2-3 minutes. I endeavoured to observe the origin in the cell of the pulsating vesicles but without success.

From each cell, whether long or short, one zoospore resulted. They are globose (diam 8.10μ), ovate (15.19μ long by 7.10μ broad) or shortly fusiform (long 16.21μ , lat 7.8μ) gradually becoming more or less linear (Text-figs 2-5). The contents are arranged exactly as in the cell but the pyrenoids scattered here and there, no Chlamydomonadine structure, flagella 4, pulsating vesicles 2 alternating, no stigma. The shape is not permanent, even while motile the zoospores begin to grow, at once passing rapidly from one shape to another and becoming longer, narrower, and more attenuate behind.

Involved among the *Ulothrix* filaments were quantities of the following species

CHLAMYDOMONAS SNOWII, var. *OVATA*, n. var. (Text-fig 6)

Forma ovata, sursum plus angustata, fronte modice acuminata. Long 8-10, lat 5.6μ .

One of the congeners of *Chl. globosa* Snow, some of which are generally to be met with in gatherings such as this (see Note 1). There the pyrenoid was remarkably large for the size of the cell, probably preparatory to longitudinal self-division of the cell, and in those under review here, many of the pyrenoids had actually divided. Cells somewhat obtuse in front are included in the type, these are more or less pointed. Chloroplasts bag-shaped or campanulate, stigma median.

There is no essential difference between thin laminar chloroplasts, those which are bag-shaped, and those which are campanulate, they are merely three degrees of development.

IV - Investigation of some green water from a duck-pond

On October 10th, 1921 (spring), being then at Tauranga, N.Z., a small quantity of green water was brought in to me from a neighbouring duck-pond. The colour turned out to be due to a small *Chlamydomonas* in the *Palmella*-state from the fine structureless mucus of which the cells were just breaking forth. As I know of no previously described form with which it can be identified I have named it after the township.

CHLAMYDOMONAS TAURANGENSIS, n. sp.

Cellulae parvae, oblongae latitudine paene exacte duplo longiores, sursum et inferne rotundatae (interdum longeovatae vel inaequales, pone subtruncatae); lateribus arenatis, saepe inaequalibus. Chloroplastis parietalis hursae-formis; stigmatibus hemisphaerico, distincto, mediano. Pyrenoidis magna, media cellula ad latus disposita.

Long 13-20, lat 7-10 μ . Tauranga, N Z

The cells were in immense numbers, both motile and non-motile. Small, and in general very irregular, they gave evidence in my opinion of having been formed by longitudinal self-division, one side being more arched as a rule than the other. Two of the largest (19 x 10 μ) that I noted lying side by side in the mucus, were however perfectly formed, in outline elliptic-oblong with evenly arched sides and broadly rounded ends. Chloroplast parietal, bag-shaped. The chief characteristic of the type is the arrangement of the stigma, nucleus and pyrenoid transversely at the centre of the cell. Pyrenoid very large, quite half the breadth of the cell, and though sometimes appearing central, is really lateral. Irregular cells have a tendency to be subtruncate below.

I met with this form once before, in company with *Chl globosa*, at Lismore, N S W (see Note 1).

Examined again on October 18th, the phial having been kept for eight days exposed to a strong diffused daylight, the mucous stratum still showed quantities of the same type, mostly non-motile cells without stigma. Clear evidence was present of their origin as autospores from a minute spherical cell of 10-13 μ diameter which is a large size of *Chl globosa*. These with 4 autospores side by side were to be noted everywhere. Well-developed specimens of *Chl globosa* (diam 8-9 μ) as 4 autospores in a mother-cell were present also.

But the most interesting item of the contents was a bizarre form of *Chlamydomonas* to which I have given the name of

CHLAMYDOMONAS NOVAEZEALANDIAE, n. sp.

Cellulae modice ovatae vel oblongae (interdum etiam subquadrangulares), in ambitu valde inaequales, permagnorum granulorum amylaceorum per membranam delicatissimam proiecitur seriebus ternis formatae, granulis plerumque rotundatis, anterioribus medianisque maximis. Chloroplastis vix visibilibus, stigmate nullo nec pyrenoidi; flagellis tenuibus, brevibus, binis.

Long 5-8, lat 3-6 μ . Tauranga, N Z

The cells were, in general outline, ovate or oblong, sometimes verging on sub-quadrangular. They are chiefly characterised by 3 series of very large rounded paramylon granules projecting through the very delicate membrane which can only be detected as a faint tag at the apex of each granule. End view shows that these are all round the cell. The two upper series are the most distinct, but the shape is very variable. A faint colouration indicates the presence of a chloroplast, but stigma and pyrenoid were alike absent. I thought I detected contractile vacuoles and a minute central nucleus, two short delicate flagella quite certain.

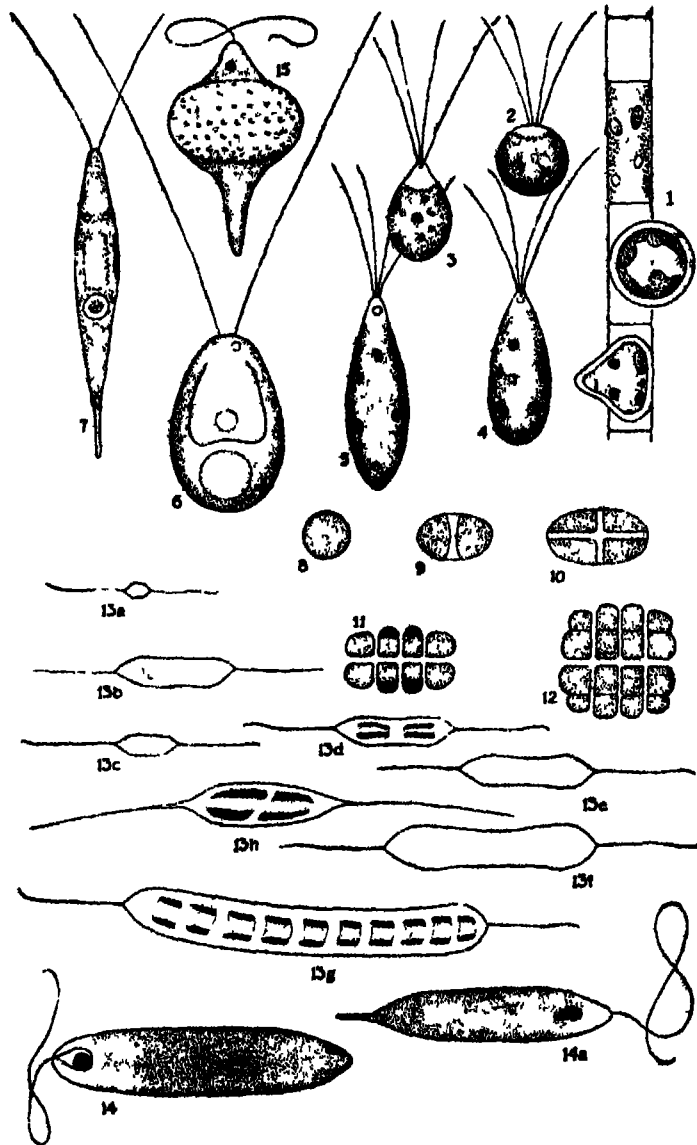
Quantities were present, both motile and non-motile, the latter often arranged in sets of four. But the point most worthy of remark is that in the original gathering *not a cell of this type was present*, so that we have here the production of a new species from a perfectly different form by repeated self-division and formation of autospores under pathological conditions.

v.—On certain forms of *Chlamydomonas*

CHLAMYDOMONAS STELLATA Dill

Die Gatt. *Chlamyd*, 1895, p. 17, T. v. f. 31-36, cf., Wille, 1903, p. 134, T. iv, f. 4.

Form without anterior papilla, chloroplasts more attenuate inwardly, stigma



Text-figures 1-15

1-5 *Ulothrix quaternaria*, n.sp. (1, $\times 800$, 2-5, $\times 1100$) 6. *Chlamydomonas* Snowii, var. *ovata*, n.var. ($\times 2400$) 7. *Chlorogonium elegans*, n.sp. ($\times 1100$). 8-12 *Gonium pectorale* Development of the cells (*Palmella-stata*) to form a 16-coenobia family 13a-h *Ophocytium capstatum* var. *longispinum* 14, 14a *Euglena australica*, n.sp. ($\times 750$) 15 *Euglena australica*, var. *gibberosa*, n.var.

not observed, syn *Chl rotula* Playf These Proceedings, 1918, p 517, Pl iv., f. 12.

Wille gives —Long 18-20, lat 10-13 μ , ours are 19-21 x 15 μ , pyr diam 6 μ
Gloeocystis-states are *Asterococcus superbis* (Cienk) Scherffel, 1908, Ber. d Bot Ges, Bd xxvii (cf Pascher, op cit, H 5, p 50, f 302) *Oocystis rotula* Playf (antea, 1916, p 130, Pl vii, f 31); *Asterococcus kmneticus* G M Smith, 1918, Trans Wis. Acad, p 627, Pl 10, f 3-6, Wisconsin Phytoplankton, 1920, p 104, Pl 20, f 7-10.

CHLAMYDOMONAS STEINII Goroshankin

Morph u System d Chlamyd, ii, 1891, pp 112, 113, T iii, f 1-8, 29, 30, Wille, 1903, p 134, T iv., f 5

Form sometimes with a minute but distinct (1 μ alt.) anterior papilla, and a pyrenoid at each end The apical one seems to be rather an agglomeration of the anterior ends of the chloroplasts Plenty noted in a floating *Euglena* scum Goroshankin's dimensions are —Cell long 18-30 (generally 24 μ)

Cell long 21-23, lat 12-13 μ Lismore

CHLAMYDOMONAS OBSCURA, n sp

Cellulae oblongae, ubique rotundatae, lateribus levissime arcuatis, fronte papilla hemisphaerica distincta, chloroplaste crassa bursae formi, cellulam paene complente, nucleo mediano, pyrenoidi nulla (in speciminibus notatis); stigmate hemisphaerico mediano distinctissimo

Long 12-15, lat 7-8 $\frac{1}{2}$ μ Lismore (N S W), Tauranga (N Z)

A small form found in a wayside waterhole draining a swamp Its general outline is oblong with broadly rounded ends, but sometimes verging on ovate from being narrowed anteriorly A very distinct hemispherical papilla in front, at least in the motile specimens Cytoplasm minutely granular, dense, chloroplast massive, almost filling the cell, leaving merely a narrow and sometimes irregular protoplasmic core Nucleus central, no pyrenoid noted; stigma hemispherical, median, very distinct

Gloeocystis-state observed —subglobose, 16-celled, diam 100 μ Cells without apical papilla, pyrenoid or stigma, but with the same dense finely granular cytoplasm and massive chloroplast.

Var. OVATA, n var

Cellulae ovatae, pone latissime rotundatae, fronte acutae, lateribus valde arcuatis. Cetera ut in forma typica.

Cell. long 12-15 Tauranga (N Z)

Found with the type, both motile This is a very decidedly ovate form. acute in front, broadly rounded behind, sides well arched Breadth doubtful

vi —Development of *Chlamydomonas*, from resting cells

On July 24th, 1915, after several days' heavy rain my attention was directed to a small green flake about the size of a halfpenny floating on the surface of a muddy roadside pool. It proved to be composed of infantile non-motile forms of some species of *Chlamydomonas*. There were all shapes and sizes, lying in an irregular plexus, held together on their sides by a thin membranous pellicle Three sorts might be noted, viz:—

a.—A comparatively few fairly well-developed cells, oval or ovate, long 13-20, lat. 8-14 μ , showing the usual bell-shaped chloroplast, very pale green and

homogeneous, with sometimes a pyrenoid or pyrenoidal locellus. The flagella might often be observed feebly fluttering.

b—A much larger section consisting of smaller long-elliptic cells about $10 \times 4\mu$. Chloroplast laminar, very slightly coloured indeed.

c—A crowd of smaller cells very irregular in shape, up to $6 \times 3\mu$ in dimensions. Very often just a trace of chloroplast with barely any colour.

In no cell was any stigma noticeable, but even in the small ones contractile vacuoles were seen working. Even as I watched the cells under the microscope one or other would become active—a few slight movements—some more decided wiggles—and it broke free. It was curious that it was always the minute and often the more irregular cells which became active, very rarely, if ever, the well-developed ones. This is quite the rule among flagellates.

The stratum examined was not a *Palmella*-state where the cells are immersed in mucus, but a tough, though delicate, papyraceous membrane with the cells affixed by their sides. This membrane I believe to be formed on the drying up of the pool by very fine flocculent matter floating suspended in the water, while the *Chlamydomonadine* cells present evolve swarm spores which survive the drought as minute resting cells adherent to it.

Consulting, as I do, from time to time, Wille's most useful monograph "Über die Gattung *Chlamydomonas*" I have been struck by the regularity of the reference to the zygote in every species. Nevertheless, though I have done a good deal of work searching just the places in which zygotes might naturally occur, I have never met with a single specimen, and, from the material I have found, have been forced to the conclusion that some alternative method of development such as I have suggested, must exist.

VII.—The Genus *Chlorogonium*

CHLOROGONIUM EUCHLORUM Ehr

The form that seems to have been generally accepted in Europe as the type is Dangeard's figure reproduced in Chodat, *Algues vertes de la Suisse*, Bd. 1, H. 3, p. 40. It is very broadly fusiform, merely acuminate behind, acutely rounded and only slightly rostrate in front. The dimensions, *l.c.*, p. 139, are given as—long $30-50\mu$, lat $8-12\mu$.

The nearest approach to such a form that I have observed was a single specimen from the Botany Water Reserve, acuminate at each end, without rostrum or tail. It was alive and active in spite of the fact that the cytoplasm was divided into 8 oval autospores. Long cell 30μ , lat 12μ .

CHLOROGONIUM ELEGANS, n. sp. (Text-fig. 7)

Cellulae graciliores, fronte acute-rostratae, pone acutissimae, sensum sensimque attenuatae.

Long $36-55\mu$, lat $6-10\mu$. Botany Lismore.

More slenderly fusiform than *Chl. euchlorum* and more gradually attenuate to each end. In front more acute and rostrate, behind very acutely drawn out almost into a spine. Chloroplast a thin parietal lamina without pyrenoids. Stigma orange-brown, wick-shaped when showing at any rate (probably, however, a delicate flat circular disc in face view) a little in front of centre. A pair of contractile vesicles about the anterior fourth. Nucleus a little behind the

centre, closely surrounded by a locellus. Cytoplasm occasionally retracted from the tail.

CHLOROGONIUM STEINII, nom. nov.

As in Stein, *Naturg. d. Flag.*, II 1, T. xviii, f. 6. The figure works out at -- Long 123, lat. 12μ .

I came across a pure culture of this large species in an iron saucepan in a fowl-yard. Both active and non-motile cells were present in abundance, the latter (as is usual in both Volvocine and Euglenoid flagellates) fixed in clumps by the anterior end of the cell to pieces of flocculent debris where they had evidently developed from resting cells. Under the microscope the vegetative cells continued to become motile.

Compared with the breadth they were very long, in front produced into a long rostrum, posteriorly drawn out into a very acute tail devoid of cytoplasm. Two flagella proceeded at right angles to the rostrum just below the extreme tip and a pair of small pulsating vacuoles indicate what may be considered the base of the rostrum. About the centre of the cell a small nucleus surrounded by a locellus almost as wide as the cell itself. I did not note any stigma. Chloroplast a delicate parietal lamina with 8 small pyrenoids arranged in a longitudinal spiral above, and 8 below the nucleus.

Cell long 62-93, lat. 7-10, lat. rostr. $1\frac{1}{2}\mu$. Lismore.

CHLOROGONIUM MINIMUM Playf.

New and rare fr. Algae. These Proceedings, 1918, p. 521, Pl. iv, f. 26.

Cell long 30, lat. $2-3\mu$.

Var. *CURTUM*, n. var.

Cellulae breviores, et fronte atque pone minus protractae.

Cell long 24, lat. 4μ . Lismore.

A shorter more immature form, less produced both in front and behind. Only a very delicate homogeneous parietal chloroplast noticeable, and a very distinct orange-brown stigma somewhat forward of the centre. Almost certainly a developing stage of the type, plenty were present in a Euglenoid scum from a roadside pool, March 12th, 1920, at Lismore.

Var. *OBESUM*, n. var.

Cellulae brevissimae, obesae, inaequaliter longe-ellipticae, et fronte atque pone obtusae, uno latere arcuato, altero deplanato.

Cell long 12-14, lat. 3μ . Tauranga, N.Z.

From a duck-pond (Oct. 18th, 1921). An extremely lively plump little growth form, distinctly green. Chloroplast very delicate, parietal, two flagella, stigma in the anterior portion easily noticeable, no other details.

With this form was noted what looked like the *Palmella*-state —narrowly cylindrical cells in pairs, pale green homogeneous contents, cell long 8, lat. 2μ .

What were probably sessile vegetative specimens of the zooid, affixed to some animalcule I obtained from a pond in the Botanic Gardens, Sydney (June 30th, 1910). Cells linear-elliptic, long 12, lat. 3μ , chloroplasts bright green, they became motile on being broken loose from the host.

VIII - Development of *Pandorina* and *Gonium*

PANDORINA

In September, 1909, I obtained quantities of small freshwater Algae by shaking out heads of *Elodea* and *Myriophyllum* growing in a dense mass close to the surface of the water in a tank at the Botanic Gardens, Sydney. Among them were numbers of *Pandorina morum*, exhibiting the various stages of development by subdivision of a single resting cell. All the forms were noted in a single drop beneath the microscope at one time and might therefore easily be compared.

a—Undivided resting cell. The smallest seen were diam $10-14\mu$ surrounded by hyaline mucus 2μ wide. Cytoplasm very pale green, finely granular.

b—Undivided resting cell. Larger size, diam $16-18\mu$, ring of mucus 2μ wide. Cytoplasm a shade darker green, finely granular.

c—Cell subdivided into a globular coenobium, non-motile, diam about $24-30\mu$. No flagella or pores visible. Cytoplasm still very pale green, finely granular with darker grains here and there.

d—Oval coenobium, non-motile, long $31-38$, lat $25-34\mu$. No flagella, but pores visible. Cytoplasm darker green.

e—Larger oval coenobium, non-motile, long $48-52$, lat 44μ , no flagella, but pores visible. Cytoplasm darker green.

Compare *P. morum* var. *tropicum* Playf. (These Proceedings, 1915, xl, Part 2, p. 336, Pl. xlv, f. 18). It seems to me quite unreasonable to suppose that these irregular polygonal cells remain so and I feel more inclined than ever to believe that they become regularly spherical and form *Eudorina elegans*.

PANDORINA MORUM VAR. COPIASTROIDEA, n. var.

Coenobium minutum globosum, *Coelastrum microporo* consimile, e cellulis minimis paene appressis exstructum, locello centrali sphaerico (ut videtur) instructum. Cellulae in quincuncem ($6+1$) dispositae, e vertice usque hexagonae, e latere cuneatae fronte rotundatae.

Coenob. diam 23μ , cell. diam 4 , locell. cent. diam 8μ . Lasmorc.

An unusual form which, owing to the extreme tenacity of the investing mucus, looks like a flagellate specimen of *Coelastrum microzorum*. The edge is crenate as the outer margin of the cells is rounded. The cells are very small (diam 4μ) almost regularly hexagonal from above and nearly appressed, arranged quincuncially 6 round 1. There appears to be a central globular locellus 8μ in diameter. Flagella distinct and the pores indicate the presence of a mucous investment.

Development of *Gonium*

In the gathering mentioned above, I was able to trace all the vegetative stages of *Gonium sociale* from a single resting cell. But how did the resting cell originate? Unfortunately, I did not obtain their dimensions but the smallest may be taken as diam 5μ .

a—Undivided pale green cell with very narrow mucous investment.

b—Cell-division in one direction, cytoplasm pale green.

c—Cell-division in a second direction, thus forming 4 angular cells.

d—Cells become globular (see my remarks under *Pandorina*).

e—Cells a diameter apart. Later they develop flagella and the coenobium becomes motile. Sometimes the cells take on an oval or ovate form. Cf. Chodat, *Algues vertes*, p. 148, f. 78.

ix.—Development of *Selenastrium* and *Coelastrum*

In the same gathering (September, 1909, *supra*) was a series of cells without mucous investment showing the development of *Selenastrium Bibracianum* from a single minute globose cell

a—Minute globose cell, diam 6μ

b—Larger globose cell, diam 12μ , chlorophyll regularly diffused

c—Globose cell with chlorophyll lunately disposed, diam 12μ .

d—Cell growing out laterally in a lunate manner, long 20, lat 10μ

e—Still more lunate, apices sharply pointed, diam from point to point 24μ , lat max 10μ .

f—A variant, long 32, lat max 14μ .

g—Fully developed cell, long 24μ , lat max 10μ .

In nature the mature cell divides along the plane of the apices and body. The new cell twists at right-angles to the first and remains attached by the centre of the body at the back. Two cells are often to be seen like this

COELASTRUM

A gathering at Lismore (December 13th, 1912), among other things, supplied me with material showing how small coenobia of *Coelastrum* are often built up from a single cell by a process of self-division in two directions

a—Single cell, diam 5μ .

b—Self-division in one direction, long 10, lat 5μ .

c—Self-division in a second direction, diam coenob 16 , cell 8μ .

d—An arched plate of six cells ($5+1$), diam coenob 22 , cell 8μ

Cells beautifully deep transparent green, a large pyrenoid in each. Small complete coenobia in same sample

x.—Rejuvenescence in *Gonium* and *Botryococcus* (Text-figs 8-12)

On two separate occasions when making observations with the microscope I was so fortunate as actually to witness this process. In the first instance it was in *Gonium pectorale*

The matrix of a coenobium having become old and stiff, it had evolved a new and larger mucous plate attached to the old coenobium. The cells had lost the flagella and become vegetative. One by one with an explosive action they left their old settings and took up positions at even distances apart in the fresh mucous ensnion. The resultant condition was Palmelloid.

Each cell undergoes self-division, first in one direction then in a second transversely, until finally a family of 16 perfect coenobia is produced (Text-figs 8-12). Such I have noted on more than one occasion and once was so fortunate as to obtain such a family showing all the stages of development. But the cell-division as observed in nature does not altogether follow the lines laid down by Chodat in *Algues vertes*, p. 42.

BOTRYOCOCCUS

The case of *Botryococcus Braunii* was similar. The cells were oval and seemed to be longitudinally divided, each being surrounded by a layer of stiff mucus. Attached was a cushion of newly formed clear hyaline mucus into which, as I watched, the cells bursting from their investment passed with a sudden and explosive jerk, becoming young and globular and settling down at about equal distances apart. The newly formed condition was Palmelloid and the old membrane fell away. Each cell should now divide to form a new coenobium. But

of what character? For it is evident that *Botryococcus* is a pathological condition of some other alga caused by the dying up of its habitat

XI—ARTHROOCYSTIN ELLIPSOIDEA W & G S West

Welwitsch's African Algae, Journ Bot, 1897, p 238, T 370, figs 1, 2 See Wille, Conj u Chlor, in Engler u Prantl, Die natürl. Pflanzenfamilien, 1909, p 39, fig 19F

This organism is probably the daughter-coenobium of *Volvox tertius* Meyer. There is an oval form of that species, and in it the daughter coenobia are generally oval also, and whether enclosed or free, the cells of the latter are often represented by a fragmented chloroplast without flagella. Compare my notes in Frw Algae of the Lismore Distr (These Proceedings, 1915, pp 340, 341, Pl xlv, fig 2, 3) under *Volvox tertius* var *tessellatus*. These daughter-coenobia, with parietal laminar chloroplast fragmented in a tessellate manner, are common enough in tropical and subtropical districts.

XII—Note on the horns of *Pediastrum*

Dealing with the genus *Pediastrum* (in Chlorophyceae, II, Heit 5, of Pascher's Die Süssw. Deutsch 1915) Brunnthaler remarks, p 89, that, according to Lemmermann, these processes (the horns) are hollow and open (fig 50) and allow a thin filament of plasma to stretch forth. Lemmermann's observation refers to *P. simplex*. Chodat (*op cit*, 1902, p 227, t 152a) has remarked the same circumstance in *P. duplex* v *reticulatum*.

In 1909 I noted it also in living specimens of *P. duplex* var *clathratum*. A Br obtained from the plankton of the lagoon in Parramatta Park. The filaments are extremely tenuous, sometimes as many as three from each horn, and occasionally vary their direction.

A Braun however (Alg unicell, 1855, p 67, footnote 1) traces this observation back to quite early microscopists. He quotes Turpin (*Mém. du Mus d'hist nat*, xvi, 1827, p 320) as saying "Lorsqu'on observe cette production dans un lieu chaud, il n'est pas rare de voir plusieurs des cornes muqueuses lancer, de leurs extrémités une poussière de globules." Turpin therefore must have convinced himself that the horns were hollow.

Braun goes on to say (*ibid*, p 67) that Ehrenberg, relying on Turpin's observation, holds the opinion (*Infus*, p. 155) that the horns are perforated by small orifices.

I watched long and carefully for Turpin's "poussière de globules" but never saw anything pass from the horns.

XIII—INEFFIGIATA NEGLECTA W & G S West

This plant is generally found as small irregular masses of a brownish-green or yellow-green colour out of pond weeds. I obtained it also from the Sydney Water Supply in large conglomerations, the pieces being connected by what were evidently strings of dried mucus. The cells are said to be disposed side by side as in *Botryococcus* but within the investing membrane.

I gathered a peculiar and unusual form of this plant from Canley Vale in some quantity. The membrane of each piece seemed to be covered with perforations through each of which protruded very slightly a low rounded papilla of hyaline transparent mucus. From the apex of these proceeded a very long delicate pituitous thread in length equal to twice or thrice the diameter of the

mass. Those threads were of quite a different character from the coarse membranous strands often found joining these masses, and under a high magnification showed no signs of being composed of *Bacterium* cells. The interior of the mass seemed to be replete with a number of large hyaline refringent bodies, one was distinctly visible through a rent in the membrane and by putting the microscope a little out of focus the position of others was indicated (as is often the case) by a refringent glow. Quantities of the usual minute pieces of the plant were observable in the same gathering—green, yellow-green, orange and even brick-red in colour. One mass measured 50μ long and broad.

xiv—On certain species of Oocystis

OOCYSTIS BORGEI Snow

Plankton of L Erie, Bull US Fish Comm, 1903, p 379, Pl 2, fig vii Syn *O. gigas* var *Borgei* Lemm, *Oe Novae Semliae* var *australis* Playf (These Proceedings, 1916, p 123, Pl vii, figs 13-17. I have lost my copy of Snow's memoir, but the identification is certain, as my figures agree perfectly with that given by A. Pascher in *Suess flora Deutschlands*, H 5, "Anhang," p 234, f 38. The dimensions for American specimens are—Long 9-17, lat 9-13 μ , European Long 13-17, lat 9-13 μ , Australian—Long 13-20, lat 10-14 μ . Ours are from the plankton of the lake in Parramatta Park and from the Richmond River at Lismore. The chloroplast is laminar, parietal, irregularly fragmented.

OOCYSTIS CRASSA Wittrock

Syn *O. crassa* var *Ostenfeldii* Playf, *forma*, These Proceedings, 1917, p 839, Pl lviii, f 1, *O. crassa* var. *elongata* Playf, *pro parte*, *ibid*, p 839, Pl lviii, f 2.

The original figure of *O. crassa* being so irregular in shape and of such doubtful characteristics, the form generally accepted as typical is broadly biconvex, not incrassate or tuberculate at the poles, with 8 chloroplasts each with a pyrenoid. Our specimens as figured agree with G S West's in *Brit Frw Algae*, p 227. In regard to size W and G S West give long 18-24, lat 13-15.5 μ for British specimens, European are recorded at—Long 14-26, lat 10-20 μ , ours are long 20-25, lat 13-15 μ .

O. crassa var *Ostenfeldii* Playf has 4 rounded discoid chloroplasts arranged generally longitudinally. My fig 3 (Pl lviii, *lc*) cannot be included under *O. crassa*, but had better be considered as *O. solitaria* Wittr. though it does not possess the polar incrassation within the membrane, characteristic of that species.

OOCYSTIS LISMORENSIS, n sp

Cellulae latissime ovales, ad polos quam levissime acuminatae non autem apiculatae vel incrassatae; chloroplastidibus disciformibus vel plusminus inaequaliter polygonis (c 6-7 utrinque visibilibus) vel circulis minoribus (diam 4-5 μ).

Dimensions 43 x 35, 38 x 31, 36 x 30, 31 x 25 μ . Lismore

A form rather difficult to place otherwise than by making it a distinct type. It is far too small to arrange under *Eremosphaera* (cf *Erem. viridis* var *acuminata* Playf., *antea*, 1916, Pl ix, f. 3). *O. gigas* Archer is oblong, not oval, with uninterrupted outline, as also is *f. minor* W West. The cells in this species are very broadly oval, the least bit acuminate at the poles, but neither incrassate there nor furnished with an apiculus or papilla. The chloroplasts are some-

times large, irregularly polygonal, 6-7 a side, or smaller and circular. The axial ratio of the cells measured averaged 1 to 1.22

xv—On two species of *Ophiocytium*

OPHIOCYTIUM CAPITATUM var *LONGISPINUM* (Möb.) Lemm. (Text-fig 13, a-h)
Hedwigia, Vol 38, 1899, p 32, Pl 4, figs 21-25

Syn *Reinschiella longispina* Möbius, *Schröderia belonophora* Schmidle
(Beitr z Kenntn d Plankt, 1900), *Centritractus belonophorus* (Schm.) Lemm.
(Beitr z Kenntn. d Plankt, ix, 1900, p 273)

In plankton from the lake in Pariamatta Park and from Enoggera (Brisbane) I observed a complete series of forms showing the growth from the initial spherical cell to a well-developed cylindrical one with 10 distinct band-shaped parietal chloroplasts

a—Cell diam 7μ , setae long 26μ

b—Cell long 16, lat 7, setae 26μ Chloroplast a single parietal lamina

c—Cell long. 18, lat 8, setae 33μ .

d—Cell long 25, lat 9, setae 57μ .

e—Cell long 36, lat 8, setae 32μ

f—Cell long 99, lat 8, setae 33μ

g—Cell long 135, lat 8, setae 35μ .

h Very small specimen, pond plankton, from Lismore Cell long 11, lat 4, setae 23μ , irregular in outline but showing 2 chloroplasts distinctly

OPHIOCYTIUM ELONGATUM W and G S West

Freshwater Algae of Burma, Pl x1, f 11-13

The Burmese type is a remarkably long irregular serpentine filament. One end is already beginning to coil, however, and f 13 shows a specimen closely spiral. No length is given, but the thickness of the cell is stated to be 5.5μ . This Australian specimen if uncoiled would certainly be as long as the type, if not longer

Crass cell 6μ Spira 90 x 30μ Guildford

xvi—Some rare forms of *Scenedesmus*

SCENEDESMUS BIJUGUS (Turpin) Lagerh

Nuova Notulae, 1893, p 158

Syn *Achnanthes bijuga* Turpin, *Scenedesmus bijugatus* Kütz.

The form I figure here is the type as given by Kützang in Synopsis Diatomacearum for his *Sc bijugatus* and which he makes equivalent to *Sc bijugus* Turpin. The cells, as he figures them, are oblong-cylindrical with rounded ends and sides flat or nearly so, 2, 3 or 4 parallel in a single series. I have only noted it once. It is a form evidently very rare, as another shape broadly oval (see Brunnthaler in Pascher, *op cit.*, H. 5, p 164, f 233) has obtained general recognition. See also G M Smith, Wisconsin Phytoplankton, Pl 37, f 18-20.

Var *DUPLIX*, n var

Cells divided transversely (not obliquely) exactly across the middle. Semi-cells slightly conical outwardly and one above the other. Each vertical pair of semicells $16 \times 10\mu$. From Fairfield, with the type

Var *IRREGULARIS*, n var.

(Cellulae interiores 2 transverse ordinatae

Coenob (4-cell) 14 x 12, 18 x 10; cell long 6-9, lat. 4-5 μ Botany Water Reserve Fairfield

The two inner cells are arranged more or less at right angles to the other two

Var *ARCUATUS* (Lemm) W & G S West

Syn *Sc arcuatus* Lemm in Plover Forsch, vii, 1899, p 17, T 1, f 2-4
Sc bijugatus f *arcuata* (Lemm) W & G S West in Plankt of some Irish Lakes, 1906, p 106, Pl x., f 12-14

Coenob (8-cell) 12-20 long, 12-18 alt, cell long 6-12, lat 2-6 μ . Botany Water Reserve Fairfield

Our specimens are small, Lemmermann gives —cell long 13-18, lat 7-9 $\frac{1}{2}$ μ . The slightly arched form of the coenobium is too insignificant a detail to found a species on, it is very often absent, the coenobium being flat

Var *DISCIFORMIS* Chodat

Algues vertes de la Suisse, 1902, p 213 "Cellules polyedriques par compression"—Chodat, *lc*

Coenob (8-cell) 18-29 $\frac{1}{2}$ long, 18-25 alt, cell long 9-15, lat 4-7 μ . Botany Water Reserve Fairfield Lismore

SCENEDESMUS RALFSII, nom nov

Cellulae ovatae alternantes, longo spatio inter se intermisso, in seriebus binis ordinatae

Cell long 16, lat 8 μ Collector

Syn *Sc obtusus* Ralis (*non* Meyen), Brit Desm, T 31, f 16 Ralfs' figures do not answer to any of Meyen's types which, also, never having been properly described, cannot be accepted. The coenobium consists of 2 alternate series of ovate cells rounded at one end and acuminate at the other and separated by a considerable interval

SCENEDESMUS ANTENNATUS Bréb

In Ralfs' British Desmids, 1845, p 222, T 35, f 27

Cell long 24, lat 5 μ Botany Water Reserve

Compare J Brunnthaler *Protococcales* (*op cit*, H 5, pp 163, 164, f 211) who gives the size of the cells as —long 12-13, lat 2.5-4 μ . See also *Sc Bernhardi* G M Smith, Wisconsin Phytoplankton, 1920, Pl 38, f 5-9, dimensions 8-17 by 3-6 μ

SCENEDESMUS RENIFORMIS, n sp

Cellulae reniformes, inter se distantes, in seriebus binis ordinatae

Coenob (8-cell) 23 x 15, cell long 7 $\frac{1}{2}$, lat 4 μ Lismore (327)

A family of eight coenobia observed. A very rare type, the cells are perfectly reniform, arranged in pairs one above another and facing opposite ways, each pair separated by an interval of about half a diameter

SCENEDESMUS CURVATUS Bohlin

Die Algen d erst Regnell Exp 1, Protoceaceen, 1897, p 23, T 1, f 41-44, 52

Very rare everywhere apparently, noted here only from Botany Water Reserve (Nos 50, 95), plentiful however in the latter gathering

Coenob, (4-cell) long 30, alt 40, cell long 20-22, lat 7-9 μ .

Coenob (8-cell) long 34-62, alt 26-44, cell long 12-24, lat 4-10 μ

SCENEDESMUS INCRASSATULUS Bohlin

Bohlin, *Protozoaceen*, *op cit*, p 24, T 1, f 45-51

Cells shortly fusiform with a minute incrassation at each end Very rare, seems to be known only from Brazil and Burma Bohlin gives 17-24 by 5-8 μ for the type

Cell. long 12-20, lat 5-6 μ . Centennial Park, Sydney Botany (Gardener's Road)

XVII—Notes on various species

ULOTHRIX AUSTRALICA, n sp

Filaments at the base very narrow, rapidly increasing to 70 μ broad with cells transversely oblong, alt 24-100 μ Upper portion of filaments 70-130 μ broad with palisade cells, alt 18-24 μ Cells not constricted or inflated Membrane 3 μ thick a short distance above the base, soon attaining 10 μ , at which figure it remains constant Inner surface of the membrane marked with delicate irregular longitudinal and transverse lines (evidently ridges) which coalesce here and there A single homogeneous parietal chloroplast filling each cell No pyrenoids or amylaceous granules.

Lismore (352) In company with the two following forms

ULOTHRIX ZONATA (Weber et Mohr) Kutz

Fil diam 27-45, cell alt 11-38, membr crass. 2-5 μ

Var VALIDA (Nag) Rabh

Fil diam 42-70, cell alt 11-32, membr crass, 3-6 μ

GOLENKINIA ACULEATA, n sp

Cellulae sphaericae, aculeis paucis arcuatis brevibus munitae.

Diam corp 20, acul long c 7 μ Sydney Water Supply (66)

All my specimens of *Golenkinia* come from that source This form is distinguished by being armed with a few short, stout, arcuate prickles, about 16 visible at a time

FLAGELLATAE

XVIII—Study of a red-brown surface film.

The film was first noticed on March 12th, 1920 (Autumn), as a thin reddish-brown pellicle with dark purple-black ripple lines where the wind had piled it. Mottled green patches showed here and there It turned out to be the matrix of a species of *Euglena* which I have not been able to identify with any published form The film broke with a vitreous fracture and the locelli which had contained the vegetative cells were scattered irregularly throughout it Circular in shape viewed from above (with delicate spiral lines showing), in side view they appeared elliptic so that the *Euglena*-cells were tabloid-shaped I have named this species —

EUGLENA AUSTRALICA, n sp (Text-fig 14)

Cellulae subcylindraceae, lateribus plus minus parallelis, vel cylindrico-fusiformes, fronte attenuatae conicae, apicibus rotundatis, pone attenuatae conicae acuminatae, spinâ brevi aut nullâ Corpore metabolico

Long c 45-55, lat 10-12 μ Lismore

When liberated from the locelli of the film, the *Euglena*-cell is tabloid-shaped. The anterior and posterior portions grow out from the centre of the broad face on either side At this stage the cell often becomes motile, stopping

every now and again to knead itself into shape. I observed all these forms to pass from one to the other under the microscope. Each had a long flagellum and was very active. I distinguish this stage of development as —

Var *GIBBEROSA*, n var (Text-fig 15)

Corpore transverse ovali, superne in projectionem conicam, interne in caudam triangularem acutam producto, metabolico. Cytoplasma plerumque flavo-viridi, denso, chloroplastidibus minutis digitis transverse dispositis, stigmatum subapicali.

Long c 36, lat c 30 μ . With the type

It may be asked why describe and name the stages of development in these metabolic forms? To prevent them from being erected into new species by other observers who come across them casually. For instance, I met with this bizarre form three years ago (April, 1917) in a gathering from another pond. It exhibited then the same characteristics — tabloid-shaped body, conical anterior prominence and triangular tail-piece both hyaline. Cytoplasm dense, yellow-green, chloroplasts minute flecks disposed transversely, stigma in the anterior prominence distinct, nucleus not visible. Body metabolic. I had myself a mind to describe it as a new species. Other observers found species on the other transition forms and thus what constitute the life-history of a single organism get strung out into a series of conventional types.

This inflated form does not persist long, breaking down gradually into —

Var *CLAVIFORMIS*, n var (Text-fig 16)

Cellulae claviformes, corpore metabolico, anteriori latissimo, inflato, pone conico acuminato, posteriori subcylindrico, fronte rotundato, paramylo nullo.

Long c 40, lat c 14 μ . With the type

Syn. *Euglena pisciformis* Dangeard (*non* Klebs) in These Proceedings, 1921, p 121, Pl IV, f 9-11. The shape of the cell is here club-shaped, simply inflated a little below the centre, acuminate behind and more or less conical in front. Much more common than the other forms. The chloroplast in all tends to be confined to the median portion of the cell, leaving the front and hind parts hyaline. It seems to be diffused or else composed of minute flecks. The nucleus is not observable and there are no paramylon rods or granules.

A smaller form — Long 30-32, lat 10-12 μ is often found.

XXIX — On *Euglena pisciformis* Klebs (Text-fig 17)

In note II. (on the examination of certain green fluffy tufts, *supra*) I recorded the occurrence of a form of *Euglena pisciformis* Klebs. Having just lately obtained Klebs' original figure and description it is evident that mine in Austr. Frw. Flagell. is not correct.

EUGLENA PISCIFORMIS var. *GRANULOSA*, n var.

Differt a forma typica pyrenoidibus geminatis, cellulae ad tertiam partem pone dispositis; parte anteriore magnis amylaceis nucleis digitatis repleta.

Cell long. c 32, lat. 8 μ . Lismore.

Compare Lemmermann, *Eugleninae* (in Pascher, *op cit*, H 5, p 125, f. 182 after Klebs). The type is torpedo-shaped, rounded in front and drawn out by degrees evenly behind to a sharp point. The internal arrangements are very characteristic as the cell is furnished with 2 clear, transparent, homogeneous, parietal chloroplasts which are very distinct and each contains a large pyrenoid, one fore and the other aft of the centre of the cell. The dimensions are given

as $25-26\mu$ long, $7-8\mu$ broad. A smaller form, var *minor* Hansging is quoted at $18-20\mu$ long, $4\frac{1}{2}-5\mu$ broad.

Our specimens differ from the type in having the two pyrenoids side by side at the posterior third of the cell, while the portion anterior to them is crowded with distinct digitate amylaceous granules lying side by side at right angles to the cell-wall. The nucleus I did not see but the CV showed up more plainly than usual close to the stigma and pharynx. The vegetative cell is subglobose, diam 16μ , and very often the characteristic chloroplasts and pyrenoids are visible in it. It is generally surrounded by a delicate irregular mucous or membranous investment. I have not observed the stages of growth.

A type very close to *Eu pasciformis* Klebs is *Eu vivida* Playf.

xx.—Development of *Euglena sociabilis* Dangeard (Text-fig 18)

Eu sociabilis would seem to be a very rare species as Lemmeimann says of it -- "Bislang nur aus Frankreich." I was so fortunate as to obtain (May, June, 1917 and even as late as October in the same year) a perfect series of its vegetative stages leading up to the motile form reproduced by me in Australian Fw Flagellates (These Proceedings, 1921, p 117, Pl III, f 8, 9). The cell undergoes development within a wide transparent hyaline investment (schleimhülle) often obviously stratified. The forms and dimensions are as follows --

a.—Cell spherical, diam $25-38\mu$, mucus diam $95-120\mu$. Cytoplasm finely granular, chlorophyll diffused, stigma generally distinct. Syn *Gloeocystis* (*Chlorococcum*) *infusorium* Schrank.

b.—Cell as in a but subglobose, long 30, lat 25μ , mucus spherical, diam. 120μ .

c.—Cell oblong, slightly pointed behind, with a small nick in front, long 53, lat 36μ , mucus spherical diam 160μ . Cytoplasm finely granular, chlorophyll diffused, stigma subapical. In these stages of development the characteristic digitate chloroplasts are not yet formed.

d.—Cell oblong, somewhat attenuate posteriorly, acuminate behind, a small nick in front, sides very slightly retuse, long 63, lat 30μ , mucus spherical, diam. 160μ . Chloroplasts digitate, stigma subapical.

e.—Cells subcylindrical, somewhat attenuate behind, subcapitate in front, sides lightly retuse, long 74, lat $21-27\mu$, one to four in a mucous sphere diam $160-250\mu$. Chloroplasts digitate, directed obliquely backwards, central lumen of the cell full of globular paramylon granules, pharynx expanded into a small nick in front, stigma distinct. (Text-fig 18.)

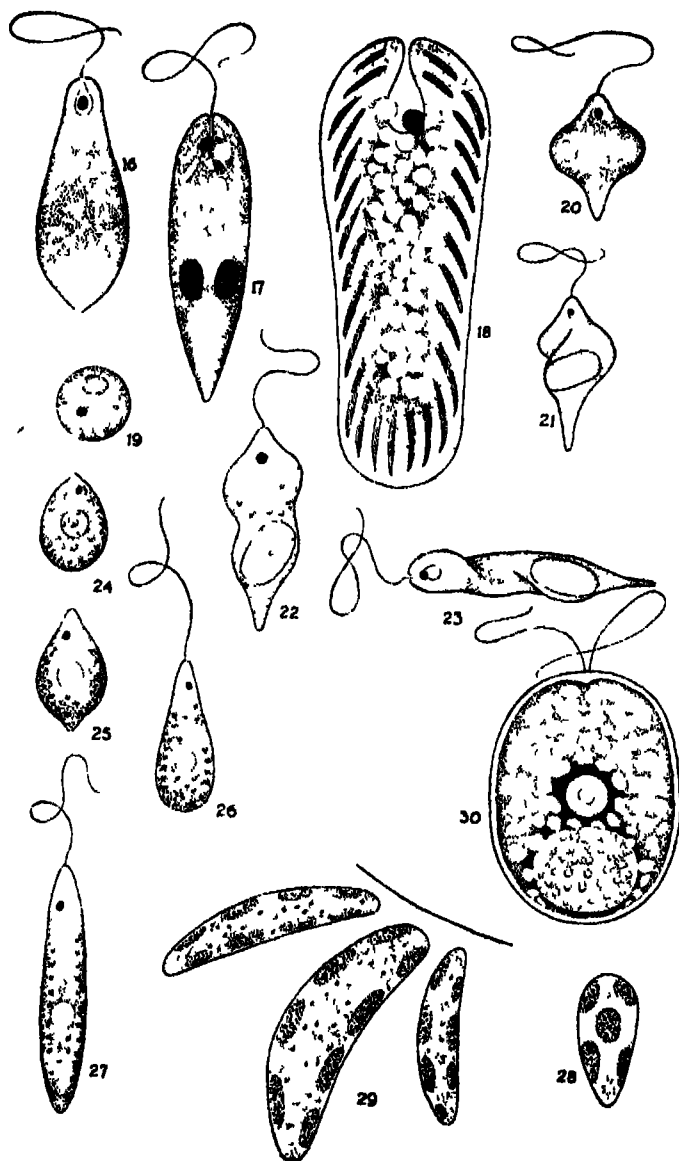
This series of vegetative forms leads up to Dangeard's zooid type, long 85-95, lat $21-28\mu$ and it seems very probable that my undescribed specimen, *lc*, Pl III, f 7, is really a more highly developed stage of this species. The disposition of the cytoplasm is the same, with the exception of the anterior chloroplasts which, as I did not observe them, are very likely disciform. Dimensions long. 110, lat 14μ .

xxi.—Life-history of *Euglena torta* Stokes (Text-figs 19-23)

On February 11th, 1922, I gathered abundance of a floating *Palmella stratum* of *Euglena* vegetative cells in course of development.

a.—Spherical resting cells, diam 25μ , cytoplasm finely granular, chloroplasts irregular patches, stigma distinct. (Text-fig 19.)

b.—First motile form, the centre of one side of the resting cell is produced



Text-figs 16-30

- 16 *Euglena australis* var. *claviformis*, n. var. (x 800) 17 *Euglena*
pisciformis, var. *granulosa*, n. var. (x 1200) 18. *Euglena sociabilis* (x 800)
19-20 *Euglena torta* Stokes (x 400) 21 *Euglena torta* var. *obesa*, n. var.
(x 600) 22 *Euglena torta* var. *curta*, n. var. (x 800) 23 *Euglena torta*
Stokes 24-25 *Euglena geniculata* (x 600). 26. *Euglena geniculata* var. *gut-
tulæ*, n. var. (x 600). 27. *Euglena geniculata* var. *juvenis*, n. var. (x 600)
28 *Colacium ovale*, n. sp. (x 1000) 29 *Colacium arcuatum*, n. sp. (x 1000)
30. *Euxeniella hma* (x 800).

into a short conical prominence, the opposite side into a somewhat longer triangular one (Text-fig 20)

c.—Var OBUSA, n var (Text-fig 21)

Cellulae corpore transverse conico, uno latere rotundato, alioque retuso, interdum modice torto, superne conico interne caudâ triangulari instructo

Second motile form, dimensions about $30 \times 20\mu$, body transversely conical, rounded one side, retuse the other, a conical prominence in front and a triangular tail behind, sometimes slightly twisted

d.—Var CURTA, n var (Text-fig 22.)

Cellulae breviores, magis oblique spirales, parte mediâ constrictâ anteriore et posteriore inflatae, fronte in conico, pone in caudâ triangulari sine spinâ protractae

Third motile form, about $35 \times 12\mu$, constricted in the centre, inflated above and below, in front conical behind triangular, without a spine. A relatively large oblong nucleus often distinctly visible in the hinder part

e.—*Euglena torta* Stokes (Text-fig. 23)

Compare Lemmermann, Eugleninae (in Pascher, *op cit*, II 5, p 130, f. 191)

He quotes 63μ long, and the figure works out at 12μ broad. Our specimens are shorter, about 40μ long and 14μ broad, cytoplasm finely granular in all forms, chlorophyll diffused or in a thin parietal lamina, tip and tail often hyaline, stigma always distinct, a large oblong nucleus in the hinder part, no paramylon rods or granules

From the plankton of a wayside waterhole on the Katikati Road, Tauranga, N Z

xxii.—*Life-history of Euglena geniculata Dujardin*

In the early part of 1922 I obtained some scanty material from a roadside drainage pool. Later I treated this with hay infusion, some blowflies fell in and decayed and a culture of brown rot fungus resulted. It was in the examination of this fungoid growth that I discovered among the hyphae a whole series of forms illustrating the development of a very graceful little species of *Euglena*. After considerable hesitation I came to the conclusion that this should be identified with—

EUGLENA GENICULATA Dujardin (Text-figs 24-27)

Histoire Naturelle des Zoophytes Infusoires, 1841, Pl 5, f 15, 16

The figure given in Pascher, *op. cit*, Heft 5 (Eugleninae by E. Lemmermann, f 206) does not in the least resemble this species. Dujardin's figures are strap-shaped or subcylindrical, rounded in front and acuminate behind, ending in a small prickle-shaped tail set obliquely. The flagellum is short and weak. Dimensions are quoted as $70-85\mu$ long and $12-22\mu$ broad. Compare also *Euglena mutabilis* Schmitz (*loc. cit*, p 181, f 203) which however is produced behind into a long spinous tail.

With these essential details our specimens agree. The chloroplast appears to be a thin parietal lamina, nucleus median and globose with a cylinder of paramylon fore and aft of it. In the interspaces a few scattered granules. Stigma small but distinct. Membrane spirally striate obliquely from left to right.

Cell. long 100, lat 12μ . Tauranga, N Z.

Three successive non-motile vegetative forms:

a (Text-fig 24) —Broadly ovate, adherent by the slightly pointed apex, long 21μ , lat 17μ , develops forward and backward along the antero-posterior axis

b c (Text-fig 25) —Cell pointed and produced in front, sometimes also behind, long 30μ , lat 16μ . Internal details of all these and the succeeding forms are the same

d, e —Var *GUTTULA*, n var (Text-fig 26)

Cellulae guttulae formes vel clavatae, fronte acutae valde attenuatae, pone latissimae, rotundatae vel levissime acuminatae. Cytoplasma granuloso. Chloroplastides laminae parietales tenues. Nucleus globosus in mediâ cellulâ. Stigma parvo distincto.

Cell long 34μ , lat 14μ . Cum prioribus tribus Tauranga, N Z

These two more developed forms noted both motile and non-motile. Cell drop-shaped or clavate, rapidly attenuated and sharp-pointed in front, broadest towards the rear where it is either broadly rounded or conical and acuminate. Cytoplasm minutely granular. Chloroplast a thin parietal lamina. Nucleus globular median. Stigma small but distinct. C'v often visible.

f —Var *JUVENILIS*, n var (Text-fig 27)

Cellulae fusiformes, subcylindricae, fronte rapide attenuatae, acutae, pone conicae acuminatae, interdum spinis minutis singulis instructae. Cetera ut in var *guttulâ*.

Cell long c $50-60\mu$, lat $10-12\mu$. Cum priori Tauranga, N Z

A young form of the type, the apex still undeveloped, being much attenuated and acute, the nucleus lies a little below the centre, the terminal spine which in the type attains a length of 12μ , was only occasionally noted. All these forms were present in quantity.

xxiii —On two new forms of *Colacium*

Among other organisms observed in the *Euglena*-film that formed the subject of investigation in Note xviii were Entomostraca bearing great numbers of *Colacium*.

COLACIUM OVALE, n sp (Text-fig 28)

Cellulae primum ovaes, deinde longe-ovatae. Zoospores lineari-ellipticae, lateribus paene parallelis, fronte acute-rotundatae, pone levissime acuminatae. Chloroplastis in fragmentis inaequalibus dispositae. Stigmatum nullo.

Cell veg long $10-18\mu$, lat 8μ . Zoosp $24 \times 6\mu$. On a *Copepod* Lismore.

Cells at first oval, then long-ovate as in *C. elongatum* Playf (These Proceedings, 1921, p 116, Pl III, f 4-6). The zooid however was not the same shape, being linear-elliptic, acutely rounded in front and slightly acuminate behind. The chloroplasts were irregularly fragmented, and neither stigma, nucleus c.v., nor pyrenoids were visible.

COLACIUM ARCUATUM, n.sp (Text-fig 29)

Cellulae arcuatae uno latere quam levissime concavae paene planae, altero latere modice convexae, apicibus acute-rotundatis. Cytoplasma minute granuloso, chloroplastidibus in fragmentis inaequalibus dispositis. Nec stigma visibile fuit, nec nucleus, neque c.v.

Cell long $18-36\mu$, lat. $5-10\mu$. On a species of *Copepod* Lismore.

Only the vegetative cells were seen, attached as usual by a mucous pedicel singly or in clusters of 2-4. They were very slightly arched, being almost flat on one side and more or less convex on the other. Cytoplasm finely granular. Chloroplasts in irregular fragments. Neither pyrenoid, stigma, nucleus nor c.v. visible.

I lost the specimens before I had a chance to detach any of the vegetative cells, otherwise a few minutes would have sufficed for them to develop into zoospores. It is noteworthy that though the cells become motile and produce flagella when detached, they show no more internal detail than was originally present.

DINOFLAGELLATAE

xxiv—On *Exuviella lima* (Ehr.) Schutt (Text-fig 30)

In 1909, when I gathered this organism alive from the creek at Canley Vale, my simple student's 1-6 in obj was not sufficiently powerful to show the necessary detail. On taking up work with better objectives in the Richmond River District which is very rich in all kinds of flagellates, I had great hopes of coming across it again, but in vain. My notes therefore in "Peridineae of New South Wales" (These Proceedings 1919, pp. 817, 818) had to be written on preserved material. It is curious then that on starting work with the microscope in New Zealand this organism should be the first living thing to meet my eye, adding a new record to its distribution in freshwater.

Shape—Our New Zealand specimens are oblong, rounded off at all points, those from the suburbs of Sydney are generally somewhat narrowed towards the flagellate end. Subcircular specimens and truncate forms may also be noted, such being the result of transverse self-division. In side view the cell is much compressed and generally slightly arched.

Cytoplasm—The contents of the cell, and its disposition, are so obscured by a layer of large irregular (paramylum ?) granules lying close together over the surface of the cell-wall, that it is difficult to see internal details.

Chromatophore—Yellow-brown or yellow-green in colour, apparently a delicate parietal lamina.

Nucleus—A large globose or transversely oblong body occupying the posterior end of the cell and extending forward as far as the pyrenoid. It has the appearance of being punctate or finely granular as shown by Penard in *Gymnodinium mirabile* and *G. helveticum* (Les Peridinacées du Lac Léman).

Flagella—There are two flagella, one stout and up-standing, about the length of the cell. The other, corresponding to the transverse flagellum in *Peridinium*, is very delicate and wavy and lies close to the margin of the cell. A notch in the front valve, not found in the other, gives exit to both flagella.

Pyrenoids—A large pyrenoid occupies the centre of each valve, being pressed close against the cell-wall to the exclusion of the granules, hence showing up very clearly. From their appearance in side-view they seem to be either plano-convex, or disciform with slightly retuse centre.

Contractile vacuole—I have not been able to locate this, even with the 1-12 in obj.

Stigma—None, nor have I ever seen the red oil-drop sometimes present in *Gymnodinium*, etc.

Habitat—Noted as a marine organism from the Parramatta River and salt-water swamps at Newington (Sydney), both the ordinary size and var *major* Playf, loc. p. 818. In these marine specimens the membrane was quite smooth, not even punctate.

Dimensions—Freshwater, 25-36 μ long, 20-26 μ broad. Var *major* 42-56 μ long, 32-45 μ broad.

Suburbs of Sydney (N S W), Tauranga (N Z)

STUDIES IN THE VEGETATION OF ARID AND SEMI-ARID NEW SOUTH WALES

PART I THE PLANT ECOLOGY OF THE BARRIER DISTRICT

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Society in Botany

(Plates xv-xxiii and six Text-figures)

[Read 27th June, 1923]

Introduction

The State of New South Wales may be conveniently divided into three main physiographic units, the Coastal Plain, the Main Divide and the Great Western Plains

The Coastal Plain varies in width according to the nature of the rocks of the Main divide and their resistance to denudation. Thus it narrows down at the MacPherson Range, the boundary between Queensland and New South Wales, where the hard volcanic rocks capping the Clarence Basin offer an effective resistance to denudation, while it widens out and reaches its greatest inland extension of 60 miles (Jose, Taylor and Woolnough, 1911, p 4) where the soft rocks of the coal measures are encountered in the Hunter Valley near Newcastle

The formation of great estuaries and harbours along the coast of New South Wales, such as those of Jervis Bay, Port Hacking, Botany Bay, Port Jackson, Broken Bay, Newcastle, Port Stephens, etc, is thought to be due to the great earth movement which brought about the upward warping of an old Eastern Australian peneplain to form the main divide, and the simultaneous downward movement of the coastal strip, which necessarily resulted in the "drowning" of river valleys and the production of deep harbours (Jose, Taylor and Woolnough, 1911, p 6)

The Main Divide occupies a broad belt of country roughly parallel with the coast and extending inland for a distance of from 150 to 200 miles. In it may be recognised a series of tablelands of altitudes ranging from a few hundred to over 6,000 feet, which mark the result of the uplift of the Eastralian peneplain during Tertiary times

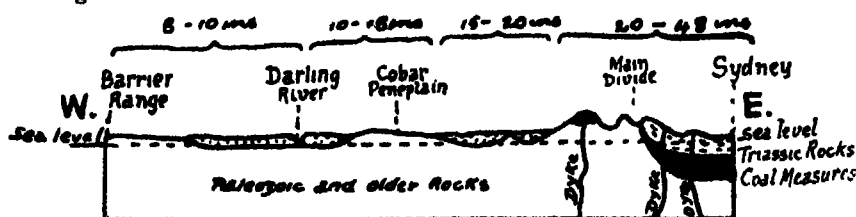
The faulting and warping which accompanied this uplift are responsible for the "blocking" of the plateau, the more or less flat tops of the hills, and for the presence of "rift valleys" or "geocols" breaking up the divide into separate tablelands. Where rivers leave the divide on its eastern and western flanks, extensive dissection has taken place and plains of alluviation have been built up

The Great Western Plains extend from the western flanks of the Divide across the Darling River to the South Australian border

For the greater part they consist of old denuded peneplains, more or less buried in their own waste, and recent alluvials such as the black-soil plains of the Darling, Murray and Murrumbidgee Rivers and their tributaries. In no place is the altitude of these western plains greater than 1,000 ft. Isolated residuals of harder rocks are occasionally found standing out above the surrounding country, but their height is accentuated by the extreme flatness which is a notable feature of the greater part of western New South Wales.

The chief of these regions of high land in the western plains are the Cobar peneplain, 125 miles east of the River Darling, and the Barrier and Grey Ranges in the far west and north-west respectively.

Not only are these high lands made up of some of the oldest rocks in the State, but they are famous for the important mineral belts which occur in them. These are the gold deposits of Mt Brown near Milparinka, the silver-lead-zinc belts of Broken Hill in the Barrier, and the copper and gold deposits of the Cobar region.



Text-fig 1 -- Section across New South Wales from Barrier Range to Sydney (after David)

The red sandy soil which characterises the greater part of these western plains, and in which the old residuals stand partly buried, is held by geologists to be largely due to the wearing down of the extensive marine deposits which were laid down upon the floor of the vast Australian mediterranean sea in Cretaceous times. These marine sediments (Desert sandstones of the Great Artesian basin) extend from Queensland into north-western New South Wales, and across to the Lake Eyre region of South Australia. The presence of a portion of the Great Artesian basin in this region of New South Wales is of vast importance in a part of the country suitable only for scattered pastoral holdings.

The south-western portion of the plains, the Riverina, is occupied by a large area of sediments laid down in the Eocene sea which invaded Southern Australia, even as far as Wentworth on the River Murray. In this belt of country sub-artesian water may be found.

The interesting geological changes which took place in late Cretaceous and early Tertiary times in Australia, and which went far towards giving Western New South Wales its present physiognomy, have been summarised by David (Jose, Taylor and Woollough, 1911, p 11) thus — "In Cretaceous geological time we see rivers like the Bogan, Macquarie, Castlereagh, Namoi, Gwydir, etc., or rather ancestors of those rivers following their present general trend, emptying by separate mouths into the Cretaceous sea, which then washed against the western foothills of our Main Divide between Dubbo and Yetman. Later a gradual uplift of this old Cretaceous sea took place from the Gulf of Carpentaria to Coonamble (in N S W), the hinge of the movement being perhaps along the Cobar to Broken Hill axis. This uplift joined by the method of "Engrafting" the Bogan, Macquarie, Castlereagh, etc., rivers on to the Darling River. The direction of flow of these rivers to the N N W or N W is thus easily under-

stood, as well as the unusual angle which they make at their junction with the Darling River, a newer river than they, started on its career by the north to south tilt of the Cretaceous basin. They thus form, with the Darling, the gigantic "boat-hook bends" so well described by Mr T G Taylor *

The North to South tilt of the Australian Continent in late Cretaceous time depressed the southern part of Australia beneath the ocean, so that the waters of the Eocene Sea crept inland to beyond Wentworth, and at least as far as the Arumpo bore

Later still a slight tilt took place in an opposite direction bringing the sediments of the Eocene sea above sea level, engrafting the Murray, Murrumbidgee and Darling, and pushing the coast line from above Wentworth down to its present position on the Coorong."

Since the receding of the Eocene sea from Southern Australia, western New South Wales has been exposed to the forces of denudation. At the same time its rivers have been responsible for extensive alluviation, and recent alluvials of the Darling and Murray and their tributaries are known to be underlain by great deposits of Tertiary and Post-Tertiary muds, sands and gravels

At the present day Western New South Wales is in the region of lowest rainfall in the State. By referring to a rainfall map for Australia (Text-fig 3) it will be seen that the isohyets are roughly parallel to the coast. When one passes from the Main Divide, where the rift valleys or geocles markedly affect the curves, and approaches the western plains, with their comparative uniformity and low relief, the isohyets are free from loops and become continuous curves

Owing perhaps to the fact that the moisture-laden south-easterly prevalent winds of New South Wales lose the greater part of their moisture in the region of the Main Divide, the western plains are characterised by decreasing rainfall as one proceeds west. The Barrier District falls for the most part within the 10 inch isohyet, while Yandama on the western slopes of the Grey Range, is the region of lowest rainfall in the State, having an average annual total of 6.55 inches

That the western portion of New South Wales is one of increasing aridity within recent geological time, is amply evidenced in the nature of the main and subsidiary stream channels. The river Darling itself, which traverses this western division of the State almost diagonally, shows such features of old age as extensive meanders, oxbow bends and anabranches. Further indications of increasing aridity are to be found in the fact that tributaries of the Darling on its western side, such as the Warrego and the Paroo, now only reach the Darling after excessive floods in their upper courses.

The Darling itself, being fed from higher regions where the rainfall is greater and more regular, is never entirely dry and only rarely ceases to flow

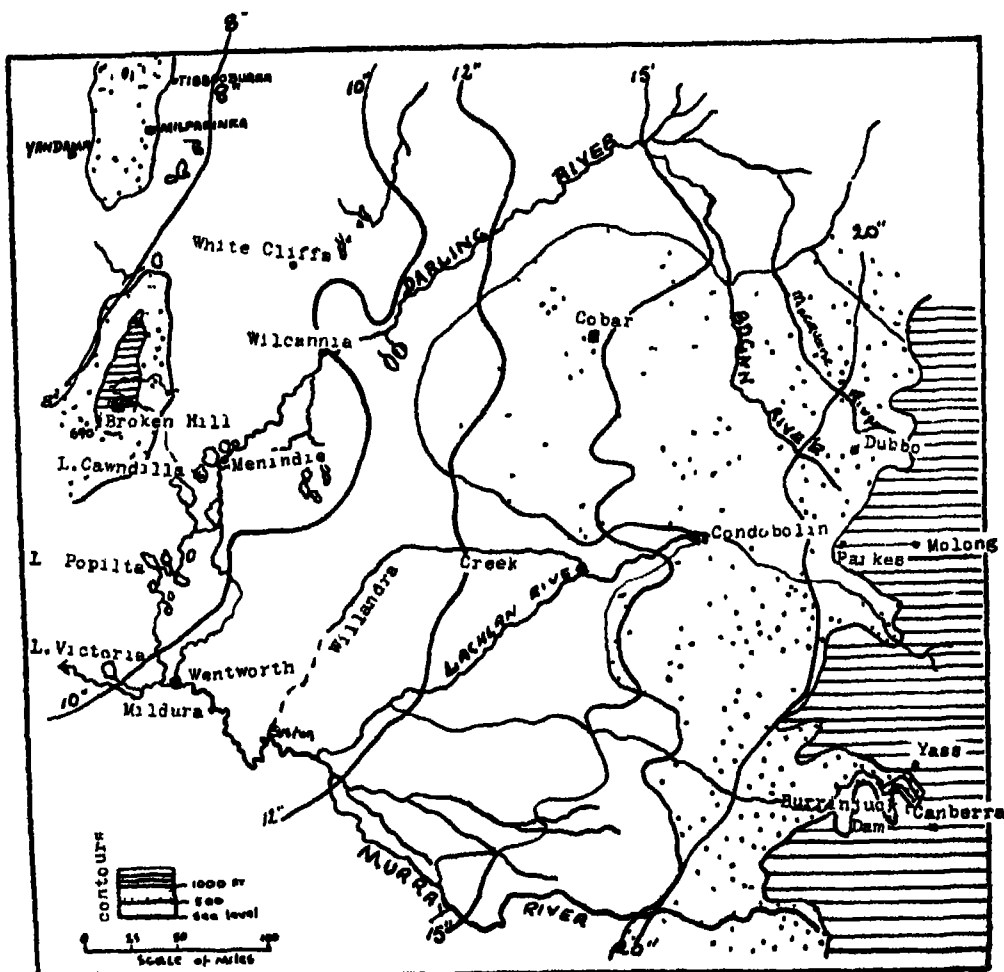
Thus the western plains of New South Wales present themselves to us as a vast area of country becoming progressively drier as we proceed west, a region which shows evidence of increasing aridity within recent geological time—a region where old residuals of ancient rocks are being relentlessly worn down to spread vast sheets of rubble and sand over the plains

Classification of Arid Regions

The Arid belt of Australia is of the typical flask shape, and, extending in

*T Griffith Taylor. The Physiography of the proposed Federal Territory at Canberra, p 8, Figs 6, 7

an east-west direction from Broken Hill in the Barrier Range of New South Wales, to North West Cape in Western Australia, it occupies 37% of the area of the Continent



Text-fig 2 --Western division of New South Wales showing isohyets and contours (after Griffith Taylor)

It is where the eastern fringe of this arid belt abuts upon western and south-western New South Wales, that zones of varying degrees of aridity occur, correlated with the decrease in rainfall as one proceeds from east to west

Although there are many to whom the word "desert" is anathema when applied to any portion of New South Wales, yet even the most hopeful must recognise, that there are often periods of years, when the greater part of the land west and north-west of the Barrier Range presents a desert facies

What are the criteria for determining whether a country shall be classified as Desert, as Arid, or as Semi-arid?

The amount of rainfall in the year is universally recognised as being an important factor influencing plant covering in these parts

Yet while realising the vast importance of rainfall and the remarkably quick response to rain by plants in drier regions, the additional effects of temperature and evaporation should not be overlooked



Text-fig 3—Average annual rainfall map of Australia (after Griffith Taylor)
Note small region in New South Wales with less than 8 inches rainfall

Various investigators have, at different times, attempted to establish some basis of classification for regions of low rainfall

Warming recognises amongst arid floras the three zones, *Desert*, *Shrub Steppes* and *Grass Steppe*, but gives no quantitative climatic basis for this zonation

He describes arid regions as those "where rain falls at quite irregular times and is continuously lacking for a long time during the season otherwise most favorable to plant growth" (1909, p 273) Amongst American workers, MacDougal establishes a basis for comparison by using extremes in rainfall amounts (1914, p. 175) while Forrest Shreve compares the rate of evaporation of the atmosphere with the moisture content of the soil (1915, p 92) Dr Cannon, in his recent investigation of the arid portions of South Australia, uses

the average annual rainfall as a convenient method of establishing boundaries for botanical purposes. He refers (1921 p. 2) to a region having 5 inches or less of rain per annum as a desert, between 5 and 10 inches as arid, and between 10 and 15 inches annually, as semi-arid.

In establishing boundaries between desert, arid, and semi-arid zones, Koppen refers to the use of definite climatic factors which influence the distribution of vegetation. In reference to arid regions, he holds that an essential feature is the absence of run-off of water. Where evaporation exceeds precipitation no streams originate. Since the temperature affects evaporation, Koppen (1918, pp. 193-203) holds that some combination of mean annual temperature with rainfall should be used to fix the arid boundary. He gives the following table combining the effects of temperature and rainfall.

Temperature	77°F	68°F	59°F	50°F	41°F
Desert Boundary	18in	11½in	10½in	9in	8in
Steppe Boundary	26in	28in	20½in	18in	16in

Since in the attempt to reach "climax" formations nature must be continually balancing and offsetting conditions of one year against another, it seems to the writer that the general physiognomy of the plant-covering (recognised as a direct response to the combination of the various factors—rainfall, temperature, evaporation, soil moisture, etc.—enumerated by the investigators mentioned above) should prove an effective means of determining the boundaries between desert, arid, and semi-arid zones.

Ecologically we have come to recognise certain distinct types of plant formation in different parts of the world.

For instance the Desert, a place where life at best is carried on under most adverse conditions, is of two types—the Ice Desert and the Sandy Desert. Again, transition zones are recognised from these desert types to less rigorous regions.

These are the Tundras on the one hand, and the Steppes on the other.

Developing upon these we recognise definite plant formations tending towards a "climax" wherever conditions are stable enough to allow a "climax" to be reached.

However, whether a stable or an arrested climax is reached, the plant covering over very wide areas is sufficiently uniform to give character to the region.

Therefore it seems possible that from ecological studies, by reference to the botanical results, upon the country, of all the combined factors mentioned above, a classification of these zones should be more truly made. However, since more information concerning climax vegetation in the drier parts of New South Wales is necessary, it is the intention of the writer, for the purposes of the present paper, at least, to adopt the classification of arid regions used by Cannon and based upon average annual rainfall.

Certain Features of Rainfall Affecting Arid Regions in Australia

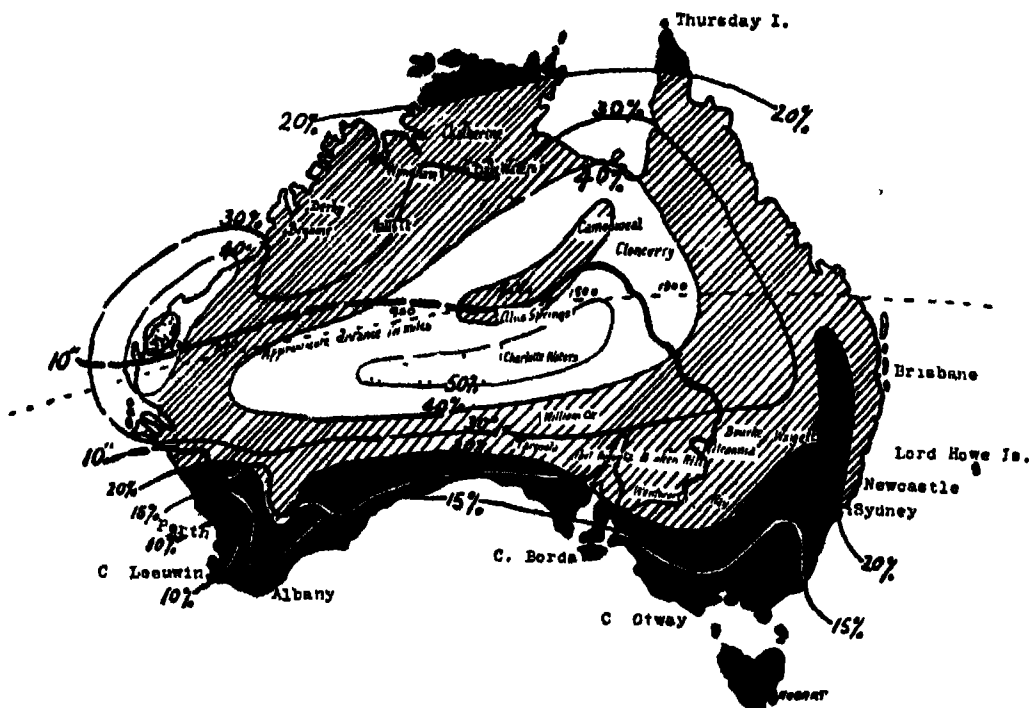
In discussing rainfall one should not overlook the peculiar variations and disturbances which sometimes result in the "desert blossoming like a garden" after years of drought, or which, on the other hand, might despoil the semi-arid lands of their rich grassy herbage, leaving burning red sand between the trees and shrubs.

There is no student of dry lands who is not familiar with the lavish response of the vegetation of these parts to good soaking rains. One cannot help but be impressed also with the fact that the vegetation of arid lands is influenced by

the time of the year in which the greater part of the rain falls, and perhaps even more by its reliability

From the economic point of view it would seem that the pastoral industry could be carried on successfully in regions of very low rainfall, provided the reliability of rainfall were good

In this connection Griffith Taylor has calculated the percentage of deviation from the average rainfall over a period of twenty years. This percentage is plotted (Taylor, 1918, p. 21) by isopleths on a rainfall reliability map (Text-fig. 4)



Text-fig 4—Rainfall reliability map of Australia with 10 inch isohyet marked (after Griffith Taylor)

It is interesting to note that the 10 inch isohyet passes through the region of great reliability (15% to 20% deviation) in the south-west portion of the continent, while in the Riverina and in the Barrier District in New South Wales (the latter to be described in the present paper) the 10 inch isohyet passes through a zone of less reliability—of 20% to 30% deviation from the average. This fact is of great importance in connection with the extension of wheat-growing into arid and semi-arid lands. Taylor has given striking examples of the different types of rainfall in regions of the same average annual total. For instance, at Roeburne in Western Australia on the 15 inch isohyet 13 inch fell in 1891, while 42 inches were recorded in 1900. Cobar, in New South Wales, also on the 15 inch isohyet, enjoys rainfall which falls almost uniformly throughout the year, whereas at Northam, in Western Australia, nearly all of the 15 ins falls

in the wheat-growing period—thus the latter is a farming region while the Cobar District is devoted to grazing (Taylor, 1920, p 332)

Rainfall reliability is possibly a more important factor in the attainment of climax formations of the vegetation, than the actual rainfall total itself

In reference to the seasonal distribution of rainfall in Australia, Taylor recognises four rain regions—Summer Rain Region in the North, Winter Rain Region in the South, Uniform in the East and Arid in the centre and Middle West. He maps Australia to show these rain regions and plots in an East and West line separating the regions influenced by Summer and Winter rain controls. By referring to the map, it will be seen that the central arid portion of Australia is affected occasionally by both these controls, and it will be shown later that, according to whether the summer or winter rain controls are dominant in the year, so will the nature of the ground flora be affected

The Winter rains are due to the westerly winds of Antarctic depressions, while the Summer rains are "largely due to the tropical cyclones which hover over Northern Australia when the sun is overhead in the Tropics, i.e., in Summer" (Taylor, 1920, p 335)

Another feature of rainfall, in relation to vegetation, is that emphasised by Dr Cannon in his recent investigation on the flora of arid South Australia, namely, that of effectivity

A certain amount of recorded rainfall is known to be ineffective as far as the more permanent plant covering is concerned, since certain falls are sufficient only to reach the root-systems of the smaller herbage and annuals. Other falls again, often coming after long periods of intensely dry weather or drought, lose a considerable amount of their effectivity owing to the run-off from the hard-baked soil surface. The importance of successive falls of rain, particularly if these be slight, is urged. Cannon defines an ecologically effective rainfall as consisting of 15 inch or more, occurring in a rainy period (1921, p 48)

By comparing non-effective rainfall for various stations of decreasing rainfall in South Australia, Cannon shows that the curve of aridity falls more rapidly than that of the recorded rainfall

Previous Investigations

Despite the great interest attaching to this region, both by reason of its vast extent (about 37% of the area of the continent) and of the great length of time during which it has been subjected to the forces of base-levelling and desiccation, arid Australia has attracted comparatively few botanical investigators

What knowledge we have of its flora has been largely gleaned from the reports and collections of such Exploring expeditions as the Horn and Elder Expeditions, conducted from South Australia, and from the collections of private individuals

Only in 1918, when Dr Cannon was sent to Australia by the Carnegie Institution of Washington, was any attempt made to visit various stations in the desert and arid zones, with a view to studying typical plants in relation to their habitats and to one another. Although confined to the arid portions of South Australia, this investigation is of particular interest, since it is the first attempt, on a big scale, at undertaking a purely botanical research in the arid belt of Australia, and since the writer was able to bring to bear upon certain Australian problems his experience of desert floras in other parts of the world

However, since the observations of this writer were restricted to one season, and that a particularly dry one, it is apparent that a complete ecological investi-

gation was impossible, and that a certain percentage of the flora (chiefly annual) was not seen by him

In the preparation of vegetation maps for Australia certain geographers, such as Schimper and, more recently, Diels and Griffith Taylor, have mapped definite vegetational regions in the arid and semi-arid belts of Australia such as "spinifex and sand," "mulga," "mallee," "brigalow," "Savannah," etc (Griffith Taylor, 1918, pp 24, 26 and 27)

It is interesting to note that, in Taylor's (1918, p 27) vegetation map for Australia, based upon that of Diels, far western New South Wales, for some distance east of, and extending within the 10 inch isohyet even to the Lake Eyre region in South Australia, is mapped entirely as Savannah. It is apparent that more detailed observation is needed in these regions, and it is the intention of the present writer to refer further to these vegetation maps in a later part of this series

Beyond references made by various geologists in their reports, the New South Wales portion of Arid Australia remains an untouched field for ecological investigation

Sir Douglas Mawson, in his report on the Geology of the Broken Hill District, makes reference to the vegetation and recognises distinct habitats such as the hills areas where "mulga (*Acacia aneura*) scrub predominates," associated with which are *Eremophila maculata*, *Fusanus acuminatus* and others. He also notes (1912, pp 230-231) the plains habitat with dominant salt bushes (species of *Atriplex*) and blue bush (*Kochia*)

Mr E C Andrews in a more recent memoir on the geology of the Broken Hill District (1922, pp 33-36), also refers to the vegetation in a general manner, and draws attention to the extensive development of the Chenopodiaceae amongst the ground flora and the Myoporineae amongst the shrubs. Mr Andrews' remarks on the flora are accompanied by a series of interesting photographs of various species

Scope of the Present Investigation

Marking the eastern limit of the arid zone, this far western region of New South Wales should offer much that is of especial interest to the student of arid floras

It appeared to the writer that an interesting series of ecological studies could be made by visiting regions in each of the rainfall belts in Western New South Wales, correlating the vegetation, as far as possible, with rainfall and other climatic factors

Although the Broken Hill or Barrier District is not the region of lowest rainfall in the State, it comes within the 10 inch isohyet, and thus occurs near the eastern boundary of what is regarded botanically as arid country. It was thus considered by the writer as a suitable starting point for an investigation of this kind

In addition to the following work upon the flora of the Barrier District, the writer has investigated the flora of the Grey Range and its neighbourhood (a region of lower rainfall, ranging from 6.55-7.5 ins) and in addition the Cobar District, east of the River Darling—a region within the 15 inch isohyet

As the results of these expeditions amply justify the plan of the writer, it is intended to publish these as separate parts of a series

Apart from the purely scientific point of view, it is felt that in a country such as Australia, where a great portion of the wealth depends upon the pastoral

industry and upon wheat-growing, any investigation which throws light upon conditions of life and growth in arid and semi-arid regions, should prove of great interest and value

The possibility or otherwise of extending our pastoral lands into the heart of the desert on the one hand, and that of subduing semi-arid lands for wheat-growing on the other, are questions continually before the Australian public

Only when we have accurate data, accurate climatic records, complete and searching investigations into the conditions of life and growth in these regions, shall we be able to judge without prejudice of the possibilities for opening up and settling this vast, waste interior of Australia.

In connection with the present work the writer wishes to express her indebtedness to Professor T. Griffith Taylor of the Department of Geography, University of Sydney, who has kindly allowed her to use certain of his climatological maps, to Mr J. H. Maiden and his staff who have kindly given her access to the National Herbarium and assisted in the identification of many species, to Dr W. MacGillivray, of Broken Hill, whose wide knowledge of the Barrier District was always generously placed at her disposal, and to Mr and Mrs Morris of the Barrier Field Naturalists' Club, who have supplied much unpublished data, as well as material and general information

The writer also wishes to express her thanks to Sir Sidney Kidman, through whose hospitality she was accommodated and given transport on various sheep stations in the district, and to Mr and Mrs. Fouls, of Corona Station, whose many kindnesses facilitated the investigation

THE BARRIER RANGE

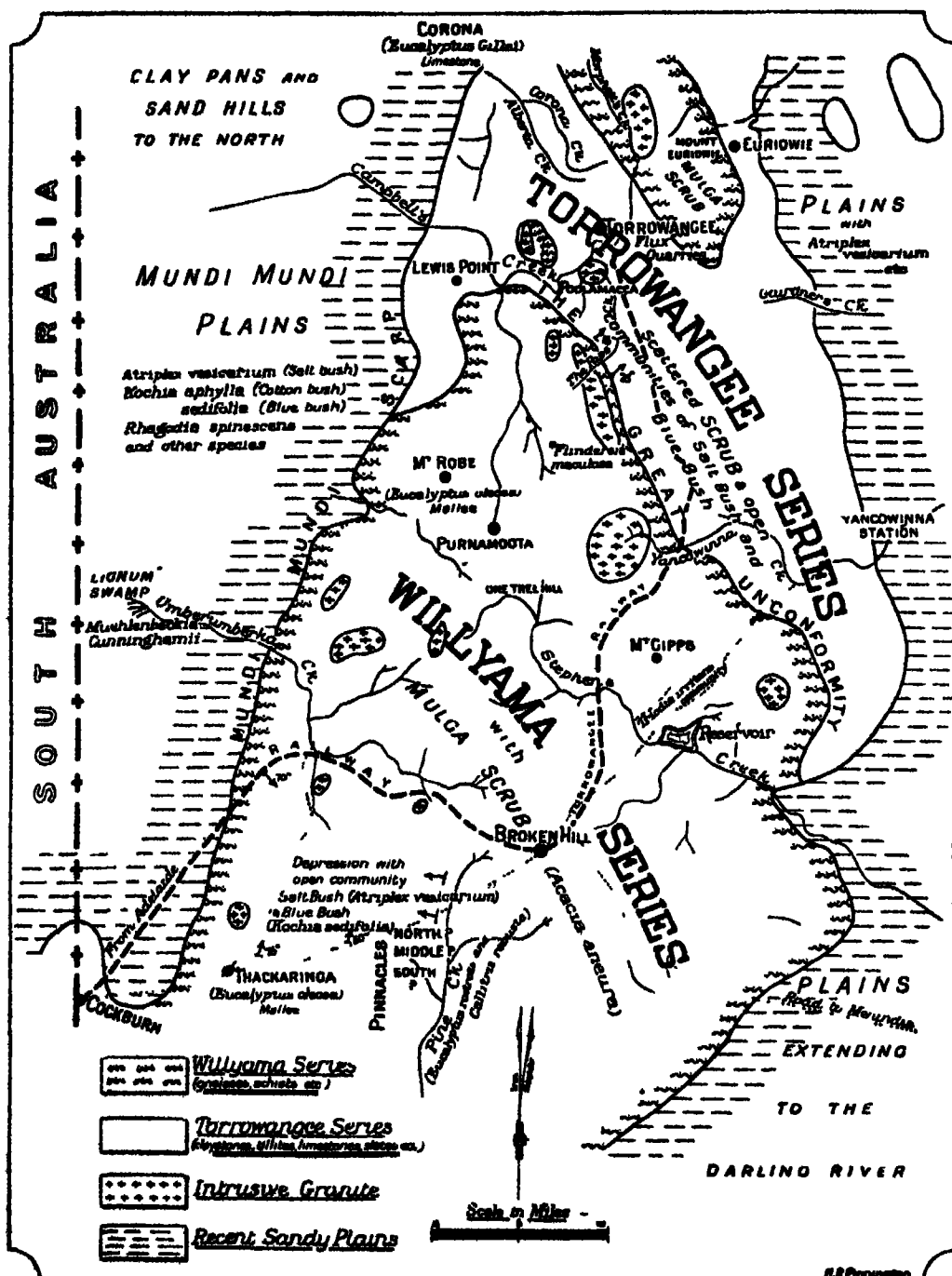
The Barrier Range is made up of low hills of ancient contorted and metamorphosed rocks which, with the exception of certain peaks, only reach a few hundred feet above the level of the surrounding plains. These hills which trend NNE are regarded by geologists as being an extension of the Mount Lofty and Flinders Range systems of South Australia. They are continued further into Queensland by the Grey Range near Milparinka and Tibbooburra

Made up as they are of very ancient rocks, the Barrier Ranges have been subjected to denudation over a considerable period of time and give many evidences of peneplanation. Occasional high peaks, such as Mount Robe (950 feet above the level of the surrounding plains), Lewis Point, and Mount Euriovie, mark irregularities in an old peneplain surface estimated as being 1,400 feet above sea-level (Mawson, 1912, p. 218)

The rocks making up this metamorphosed complex, are found by geologists to belong to two distinct and unconformable series, which have been named the Willyama or Broken Hill Series, and the Torrowangee Series. In his recent report on the Geology of the Broken Hill District, Andrews (1922, p. 107) has placed the age of the Willyama Series as Archaean and that of the Torrowangees as Pre-Cambrian

The Willyama Series is made up for the most part of gneisses, schists, amphibolites, etc., amongst which occur the famous Broken Hill sulphide ore deposits. These rocks dip under the Torrowangee Series of quartzites, tillites, limestones and claystones at Poulamacca, 40 miles north of Broken Hill, while they outcrop again as an inlier 10 miles further north (Andrews, 1922, p. 38), where they extend past Mt. Euriovie to Corona (Text-fig. 5)

A feature of interest in the Torrowangee Series, and one which plays no small part in the establishment of vegetation, is the occurrence of enormous dykes



Text-fig. 5.— Geological sketch-map of the Broken Hill district, with plant associations indicated (based on map by Douglas Mawson)

and irregular masses of white quartz, which break up and spread out over the plains and slopes as sheets of white siliceous rubble. The weathering out of quartzite boulders from the tillites of the Torrowangee Series is also responsible for the presence of rubble sheets on a larger scale. As will be shown later these rubble sheets form a particularly adverse habitat for the establishment of seedlings.

The plains by which the Barrier Range is surrounded extend on the eastern side for a distance of about 65 miles, falling gradually to the Darling River which is 600 feet below the level of Broken Hill. On the west they extend from the bold scarp characterising the western side of the Range, to the Boolcoomatta Hills in South Australia. To the south the plains stretch beyond the Darling River through south-western New South Wales, into Victoria and South Australia, while in the north their extent is limited by the Grey Range and the Desert Sandstone Formation outcropping near Milparinka and Tibbooburra.

Andrews recognises three types of plain in the Barrier District—(1) The Mundi Mundi plain, a narrow alluvial plain bounded on the west by the Boolcoomatta Hills in South Australia, and extending in a northerly direction beyond Corona.

(2) The Darling River type which he describes as "a very broad valley of alluvium dotted here and there with low rocky ridges and hills" representing "the gradual burial of an old system of valleys and inter-valley ridges" (Andrews, 1922, p. 23).

(3) The third type is the Northern Plain, in which only shallow patches of true alluvium occur, the rest being rolling stony and sandy country, marked here and there by stony residuals standing high above the general level. These northern plains are characterised by the extensive development of sand ridges 10 to 30 feet in height, running approximately east and west, roughly parallel, and separated by hard clay-bottomed flats.

Physiographic Features

The physiographic features of the Barrier Region are distinctly those of an arid cycle, in which transportation and redistribution of denuded material by wind are important factors.

The low, undulating hills of the Barrier Range form but a slight relief from the monotony of the surrounding plains. Several creeks originate centrifugally in the hills, the chief of which are Stephen's Creek which flows in a south-easterly direction for about 125 miles to the Darling River plain, and the Uمبرumberka Creek which rises to the west of Broken Hill and loses itself eventually in a swampy region on the Mundi Mundi plain.

The stream channels at the present time are little more than sandy courses lined by tall gum trees (*Eucalyptus*) and are known locally as "gum-creeks". The choking up of the channels with silt and sand and the cutting down of a narrower bed within the old stream channel indicate increasing aridity within recent times. Water rarely flows in any of these creeks at the present time, the rainfall being now insufficient and the evaporation too great. Local thunderstorms, however, often cause rapid flow of volumes of water, but only for a few hours.

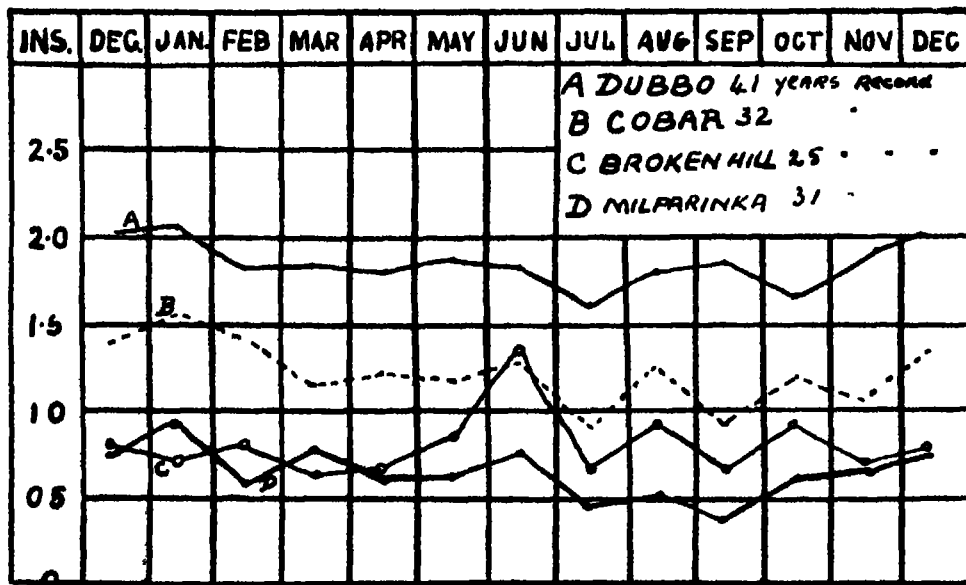
A further indication of aridity is to be found in the fact that the creeks generally lose themselves on the plains by spreading out into "lignum" swamps (*Muehlenbeckia Cunninghamii*).

Climate

Rainfall—As has been shown above, the area under investigation is one of relatively low relief, hence there are no marked deviations in the rainfall curves for this portion of the State. The Barrier and Grey Ranges appear to have little influence on the nature of the rainfall, and this is also true of the Darling River basin, which is situated upon an old alluviated flood-plain. The average annual rainfall for the Barrier District ranges from about 8 to 10 inches. Corona, about 60 miles north of Broken Hill, has an average annual rainfall of 8.35 inches, while the average for Broken Hill, taken over 20 years, is 10.02 inches.

A noteworthy feature of the rainfall of the Western Division in New South Wales is its uniformity.

The following graph, based upon that of Griffith Taylor (1918, p. 139) and the table of average monthly rainfall compiled from the records of the Weather Bureau, Sydney*, give some indication of the character of the rainfall and its uniformity in these parts (Text-fig. 6).



Text-fig. 6—Graph representing average monthly rainfall for western towns in New South Wales (after Griffith Taylor)

According to Taylor, such uniformity is due to the overlapping of summer and winter rain controls. In summer, with the southern movement of the sun accompanied by the chief wind systems, tropical and monsoonal rains affect the north of Australia, and even extend as far south as 32° Lat. In the winter (June), on the other hand, the effect of the Roaring Forties and Cyclones is felt as far north as Brisbane (Jose, Taylor and Woolnough, 1911, p. 263).

*The weather records used in this paper were kindly supplied by Mr. Mares, Bureau of Meteorology, New South Wales.

In the overlapping region rain results from both these sources, and a degree of uniformity follows

TABLE I
AVERAGE MONTHLY AND ANNUAL RAINFALL (IN INCHES) FOR STATIONS IN NEW SOUTH WALES
AND SOUTH AUSTRALIA

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
NSW													
Sydney	2.61	4.45	5.03	5.39	5.16	4.90	4.88	3.03	2.89	2.95	2.36	2.87	48.04
Dubbo	2.09	1.69	1.90	1.78	1.88	2.03	1.66	1.79	1.75	1.59	1.82	2.15	22.13
Cobar	1.46	1.35	1.01	1.05	1.14	1.34	1.29	1.21	1.26	1.13	1.12	1.47	14.15
Wilcannia	.84	.84	.96	.69	1.13	.98	.60	.81	.75	.99	.68	.76	10.13
Broken Hill	.72	.87	.61	.71	1.02	1.26	.71	.94	.81	.91	.72	.80	10.08
Correns	Monthly averages not available												
Milparinka	.96	.55	.72	.39	.67	.83	.47	.46	.44	.64	.67	.73	8.35
Tibbooburra	.74	.97	.85	.50	.46	.98	.52	.48	.49	.64	.78	.90	8.32
Yandama	Monthly averages not available												
SOUTH AUSTRALIA													
Oodnadatta	.71	.71	.57	.18	.23	.64	.28	.11	.32	.34	.38	.38	4.85
Lough's Creek (Copley)	.67	.52	.80	.54	1.06	1.11	.50	.69	.75	.47	.53	.76	8.40
Queira	.64	.45	.61	.96	1.58	2.03	1.30	1.34	1.31	1.32	.87	.65	13.8

TABLE II
YEARLY EVAPORATION RAINFALL AND TEMPERATURE FOR
STATIONS IN NEW SOUTH WALES

Station	Evaporation Inches	Rainfall Inches	Temperature
Sydney	38.014	48.04	63.1°
Dubbo	46.36	22.13	63.45°
Wilcannia	61.71	10.03	66.5°
Broken Hill	55.22	10.08	64.6°

It will be seen from the graph (Text-fig. 6) that Cobar and Milparinka are not influenced by winter control, whereas Broken Hill in the Barrier Range

shows a decided winter maximum. On Taylor's map of the rain control regions in Australia, the Barrier District occupies a position slightly to the south of the boundary between the summer and winter rain zones.

With regard to rainfall reliability, the Barrier District comes within the region of medium reliability, the deviation being between 20% and 30% (Text-fig 4).

Although this deviation seems small in comparison with that of the desert region around Charlotte Waters, where the deviation is over 50%, the Barrier Region is nevertheless affected to a large extent by the periodic droughts—so consistent a feature of dry regions—and often may endure periods of more than a year when no effective rain falls.

There is no doubt that these periodic rainless times exercise a controlling influence in giving the more permanent flora its distinctly xerophytic stamp.

Temperature, Humidity and Evaporation—The Barrier District resembles most arid regions in that its winters are cold and frosty and its summers very hot. The mean annual temperature for Broken Hill is about 64.5°, but during the summer there are often continuous periods of high temperature exceeding 100°. The mean maximum temperatures for January and February just exceed 92°, while extreme maxima for these months of 114.9° and 115.9° were recorded in 1896.

Since the relative humidity is low (the wet bulb average not exceeding 62°) evaporation is necessarily high and in Broken Hill reaches an average of 85.2 inches. The direct result of this high evaporation is the absence of actively running streams, except after heavy rainfall.

Winds—In arid regions, winds influence vegetation greatly in distribution, establishment and desiccation.

The Broken Hill District is subjected periodically to violent windstorms, during which great quantities of dust and sand are transported. These dust storms usually occur in a dry season, when the ground is bare of its covering of undershrubs and herbs.

Apart from these periodic visitations, there are the regularly occurring circular whirlwinds known as "willy-willys" continually moving sand and debris. The building up of dunes and sand-ridges is taking place extensively in the Barrier region, on the Northern plains, and at certain places on the Darling River plain, at Menindie in particular.

Wind-swept waste areas are commonly seen on pastoral holdings in the neighbourhood of Broken Hill, where over-stocking and over-grazing took place in past years.

These areas are particularly common on clayey regions where the wind has removed the surface soil, and the new clayey surface has been polished and hardened by the impact of wind-driven particles. These hardened bare areas resemble the clay-pans to be described later, and are particularly adverse habitats for the re-generation of vegetation, being unfavourable to the establishment of seedlings.

Further evidence of the activity of wind in the Barrier District is to be found in the spreading out of great sheets of siliceous and ironstone rubble over the slopes and plains.

Quartz and ironstone fragments found in these rubble sheets are the result of fragmental weathering of the large quartz and ironstone masses so prevalent in the range. The subsequent frosting of the quartz and intense polishing and rounding off of the ironstone, result from the impact of sand particles transported by the wind.

Vegetation

As has been indicated above, the vegetation of the Barrier District is of a distinctly xerophytic stamp

The leaves are sclerophyllous and often hard and leathery in texture. Spinescence on a small scale is a common feature in the shrubs, as is also the development of prickles and other thickenings, characteristic of floras subjected to great drying

The development of clothing hairs is a noteworthy feature of numerous species of under-shrubs, such as the *Amaranthaceae*, certain *Chenopodiaceae*, *Compositae*, etc

Glandular hairs which secrete resin in abundance also occur frequently, and in such families as the *Myoporineae* and *Sapindaceae* are responsible for the lacquering of the leaves Succulence is a feature which is developed very sparingly amongst the larger shrubs, but is commonly met with amongst such under-shrubs as the *Chenopodiaceae*, *Zygophyllaceae*, etc

In leaf-form there is a preponderance of the long narrow type such as in species of *Eremophila*, *Heterodendron*, *Pittosporum* and the phyllodia of several *Acacia**, these are either vertical or pendant, and assume the position, parallel to the incident rays of light, commonly found amongst xerophytic floras

Reduction of leaves and phyllodia is indicated in certain species, while aphyllly occurs in such plants as *Sarcostemma australe*, *Exocarpus aphylla*, *Templetoma* and others

Leaf-fall is not found in the true sense of the term, though certain species of *Acacia* and *Cassia* lose their phyllodia and pinnae in very dry weather, recuperation taking place after rains

In growth forms, the flora of the Barrier resembles that of other arid regions in that the Umbrella type of small tree or shrub is developed extensively This is due to the peculiarly compact manner of branching,—the laterals overtaking the main trunk and remaining close set, causing the typical canopy or umbrella form

Amongst the annual ground flora the prostrate position is favoured and numerous species chiefly of *Compositae* adopt closely set mat forms.

Ephemerals are well represented amongst the ground flora and in a bad season many annuals never reach more than dwarf form

In general configuration the flora of this region shows a preponderance of shrubs of varying sizes, amongst which species of *Acacia*, *Cassia*, *Eremophila*, *Dodonaea*, etc., are dominant Small trees are, for the main part, but little higher than tall shrubs, species of *Pittosporum*, *Hakea*, *Fusanus* (Quandong) and *Myoporum* (Sandalwood) being classified with these

Tall trees are relatively few, the most important being the River Red Gum (*Eucalyptus rostrata*), the Mallees (*E. oleosa*, etc.), the Beefwood (*Grevillea striata*), the Oak (*Casuarina lepidophloia*) and the Pine (*Callitris robusta*)

The undergrowth is made up of small woody shrubs (*Malvaceae*, *Solanaceae*, *Amaranthaceae*, *Chenopodiaceae*) and under-shrubs (*Chenopodiaceae*, *Zygophyllaceae*, etc.)

Partly owing to the compact and non-spreading nature of the branching, and partly perhaps to the position assumed by the leaves, there is little or no shade cast by the shrubs and small trees in this district However, as a result of the autumn and winter rains, there is a prodigal response of the ground flora, amongst which numerous families are represented.

For the most part, Grasses are but sparingly developed in comparison with regions of greater rainfall and, when present, they generally adopt the tussock form

The Habitats.

In the immediate neighbourhood of Broken Hill and for a radius of about twenty miles from the town the vegetation cannot be regarded as being at all representative. In the early history of the development of the mining township of Broken Hill, trees were ruthlessly cut down and used for all manner of purposes—mine timbering, homes for the miners, firewood, etc. With this wholesale destruction of tree and tall shrub vegetation, general deterioration of the flora naturally followed.

With the coming of man's domestic animals, particularly the goat, the work of destruction continued, on account of the repeated browsing down of the seedlings of woody plants.

At the present day the neighbourhood of Broken Hill presents a barren and desolate appearance, only a few trees and shrubs remaining on the higher slopes of the hills, the lower slopes and flat ground showing rocky and sandy patches with a sparse vegetation.

Unnatural as these surroundings are, they are nevertheless interesting, since it is here that we can look for signs of regeneration and succession, it is here also that the recolonisation of waste lands may be studied, and the effect of an alien invasion noted.

It is only when we pass beyond the limits of habitation, and beyond the town common, that the hills and plains give truer evidence of plant development and relationships.

The fact that the district under examination is one of fairly low relief, accounts for the absence of sharply defined habitats such as are found in other parts of the world where arid regions extend to higher altitudes.

If one makes allowance for a certain amount of overlapping on their boundaries, one may recognise such habitats as rocky hills and slopes, creek beds and minor drainage channels, plains, and sandhills. The first bears a definite scrub flora of tall shrubs and small trees in which species of *Acacia* are dominant. There are also lower strata of smaller perennial shrubs and a ground flora of annuals, in which the Compositae are abundant. Where the slopes abut upon, or gradually pass into the plains on either side of the range, there is a mingling of this ground flora with the Chenopodiaceae characteristic of the plain.

The beds of creeks and drainage channels offer favourable conditions of establishment and, owing to the better water relations, large trees are found lining the watercourses, the chief being species of *Eucalyptus* (Gum) and *Acacia*. These better water relations apparently extend to the flats and slopes adjoining the creeks, where shrubs are found to attain a fuller growth.

The plains habitat comprises areas of sandy soil, in which the sand sometimes reaches a great depth, and in other places overlies a clayey sub-stratum. The chief plants populating the plains are perennial Chenopodiaceae, of which species of *Atriplex* and *Kochia* are dominant.

There are certain distinct regions within the plains which may be regarded as minor habitats. These are the clay-pans and the flooded flats surrounding the larger of these. The clay-pans are bare, slightly depressed areas, roughly circular in outline, with hard clayey floors.

In size they range from embryonic pans to extensive areas which form definite inland lakes after good rains. Interesting examples of large clay-pan lakes in the Barrier District are Lake Bancanya and Lake Cobham (Text-fig. 2).

The clay-pans represent definite depressions in sandy country where water accumulates after rains. By evaporation, the salts contained in solution are de-

posited in the surface layers of the pans. Upon drying, the clayey floor of the pan becomes sun-baked and, after a dry season, extensive sun-cracks occur. The clay-pans are adverse habitats, chiefly on account of the hardness of the floor and the consequent difficulty of establishment of seedlings.

Generally speaking small pans are bare but for a few *Chenopodiaceae* such as species of *Babbagia* and *Bassia* which are early colonisers of bare areas in these parts. A cane grass (*Glyceria ramigera* F v M) often completely reclaims clay-pans in the northern part of the area.

Large clay-pan lakes are generally bordered by flooded flats in which the dominant plant is the Black Box—*Eucalyptus bicolor*.

These flooded flats or "Box-Flats," as they are locally called, apparently depend upon periodic inundation for their existence. It is in such flooded regions that the "Nardoo" (*Marsilea* spp.) forms close carpet-like communities.

The Sandhills Habitat—As in most regions where moving sand is a feature of the landscape, all stages may be observed from small transitory hummocks through embryonic and mobile dunes, to the more or less fixed sand-ridge, with its more stable vegetation.

Since sand-ridge vegetation will be dealt with more fully in the second part of this series, the present paper refers only to the vegetation of the small mobile dunes often found in the neighbourhood of Broken Hill.

Apparent the water relations are fairly good on these dunes since there is abundant covering vegetation—chiefly annual, after good rains. *Salsola Kali* is an early coloniser. Prostrate mat-growths are very common and act as good sand binders. There is very little tree vegetation developed on these smaller dunes—species of *Casuarina* and *Callitris* appearing sparingly.

The Vegetation of the Rocky Hills and Slopes

As has been shown, the rocky hills of the Barrier Region are made up, for the most part, of a complex of exceedingly old rocks of Archaean and Pre-Cambrian Age.

The former of these, gneisses, schists, etc., yield upon denudation a coarse sandy soil, which soon becomes of the red colour characteristic of arid regions. The latter, the Torowangre Series, are characterised by extensive deposits of slates and limestones, and it will be shown that these outcrops show some differences in plant covering.

Owing to the absence of any appreciable altitude, there is not observed any marked difference between undulating summit and slope habitats.

Where the rocky hills are intersected by creeks and minor drainage channels, slight differences in vegetation are noted, but only in the introduction of certain new species regarded as local invaders. Where the slopes merge into the plains, however, large sheets of rubble are spread out, and differences are more marked. These will be dealt with later in reference to rubble slopes.

Mulga Scrub—The vegetation of the rocky hills and slopes is comparatively luxuriant. It is distinctly a sclerophyllous scrub or bush, in which the genus *Acacia* is dominant. This scrub is known locally as Mulga Scrub, so called since the most characteristic species over large areas is the mulga, *Acacia aneura* F v M*.

*The term mulga is sometimes used for other species of *Acacia*, as *A. Inopkylla* the "sandhill mulga" (Cannon 1921, p. 60). *Acacia aneura* is the species most widely known as Mulga in Australia and in this, as in other instances, indiscriminate use of popular names only leads to confusion.

A tall, fairly compact shrub, or at best a small tree, the mulga, in this district, reaches a height of from 10-15 feet (Pl xv, figs 1, 3)

The umbrella-form of growth adopted by so many perennials of arid regions is markedly developed in *Acacia aneura* and is a feature by which it is known throughout Australia. Forms are recognised also exhibiting differences in width and texture of the phyllodia

In certain parts of the district other *Acacias* assume the role of co-dominant with, or sub-dominant to *Acacia aneura*, the most important of which is *Acacia tetragonophylla* F v M a large, compact, prickly shrub with minute phyllodia arranged in groups of two and three. From the impenetrable thickets sometimes formed by this species, as well as from its prickly phyllodia, it has come to be known as the "Dead-finish" (Pl xv, fig 2)

Other *Acacias* are *A. cana* J H M, *A. Oswaldi* F v M, *A. (Arnei)* J H M, *A. ventris* F v M, *A. Burkittii* F v M, *A. Loderi* J H M, etc

Second only to the *Acacias* in importance here are the *Myoporineae*, represented by many species of *Eremophila* and more sparsely by *Myoporum* and *Pholidia*. The *Myoporineae* are an oreman family par excellence and, though mostly shrubs in form, exhibit great variety in leaf type and protective device. The beautifully marked and coloured bell-shaped flowers of the *Eremophilas* are very striking in a bush where grey-green is the prevailing tone.

Together with the species of *Dodonaea* (Sapindaceae) found in the mulga scrub, some of the *Eremophilas* afford interesting examples of the phenomenon of leaf-lacquer due to the secretion of resin by glandular hairs. Other species of *Eremophila* exhibit, in varying degree, the development of clothing hairs. It is the intention of the writer to refer, in a later paper, to the possible correlation of this development of clothing hairs and glandular hairs with the internal leaf structure.

Although the greater number of plants in this habitat are tall shrubs of uniform size there are, nevertheless, certain trees entering into the association. The most important of these are *Eucalyptus acuminatus* R Br (the Quandong), *Casuarina lepidophloia* F v M (the "Belah" or "Oak"), *Grevillea striata* R Br (the "Beefwood") and *Eucalyptus oleosa* F v M (the mallee).

These trees are scattered as a rule, the Quandong and Beefwood being found freely mingled with the shrub vegetation.

The "Belah" or "Oak" appears to seek better light relations, however, evidence of which is found in the occurrence of small "oak" communities on the higher ridges such as that near Thackaringa.

The mallee is not common in the Barrier Range, being represented by a few isolated "pockets". On such high elevations as Mt. Robe, the mallee assumes more control and covers large areas on the hillsides. Other localities for *Eucalyptus oleosa* are the hillsides at Thackaringa and Apollyon Valley, where the mallee spreads from the floor of the valley to the summit of the hills.

Other interesting trees of this association are *Myoporum platycarpum* R Br (the Sandalwood), *Pittosporum phylliracoides* D C, *Santalum lanceolatum* R Br., *Exocarpus aphylla* R.Br., and *Hakea leucoptera* R Br (the needlewood).

The undergrowth in this habitat is for the most part made up of low shrubs and under-shrubs, and a ground flora of numerous types of annual plants.

Most important of the low shrubs are species of *Cassia*, such as *Cassia Sturtii* R.Br., *Cassia eremophila* A. Cunn and *Cassia artemisioides* Gaud. Others are *Prostanthera striatiflora* F.v M., *Senecio anethifolius* A. Cunn, *Sida virgata* Hook., and *Solanum Sturtianum* F v M.

The under-shrubs chiefly occur on the lower slopes, or where degeneration has taken place owing to clearing, burning or other causes. They are mostly species belonging to the Chenopodiaceae more commonly met with on the plains habitat, such as species of *Atriplex*, *Kochia*, *Enchylaena*. Other Chenopodiaceae enter extensively into the ground flora, but more particularly on the lower slopes where these merge into the plains. Various species of *Bassia* are common in such places.

Certain grasses enter into the composition of the ground flora, species of *Aristida* and *Stipa* being noteworthy, other important grasses are species of *Danthoma*, *Pappophorum*, *Neurachne*, etc. Since the tussock form is adopted in this region the grasses very rarely colonise large areas to the exclusion of other species.

The bunch grass or "spinifex," *Triodia irritans* R Br, which occurs over such wide areas in the sandy desert of Central Australia, is not common in the Barrier Range. It has colonised a bare region beyond Stephen's Creek fairly extensively (Plate xxi) but, apart from this locality, is only found in a few patches on the range where sand has accumulated.

Parasites in the mulga scrub association belong to two families—the Loranthaceae and the Santalaceae, the latter being root parasites. Of the Loranthaceae, *Loranthus Quandong* Lindl, *L. exocarpi* Belir, and *L. miraculosus* Miq are the most common species in the Barrier District and occur freely on many species throughout the scrub. The Acacias are most heavily affected and one commonly finds groups of trees killed by the parasite. Species of *Acacia* which have been weakened by the attack of *Loranthus* are commonly infected with the fungus *Uromycladium Teppermanum*, by which the work of destruction is completed (Pl. xviii, fig. 10).

The Santalaceae are small evergreen trees of the scrub and are represented by *Erocarpus aphylla* R Br, *Santalum lanceolatum* R Br and *Fusanus acuminatus* R Br (the Quandong).

On the slates and limestones of the Torrowangee Series, which outcrop in the hills north of Broken Hill, near Euriowie and Torrowangee, and are found on the Poolamacca and Corona runs, a less luxuriant vegetation occurs (Plate xv, fig. 3). This may be due to the less favourable water relations, or to the physical and chemical properties of the soil, or perhaps to the fact that the slate outcrops merge into the plains by low undulations, such as near Old Corona, and are extensively grazed over. In view of the occurrence of grassland upon slate outcrops, such as in the Mt. Lofty Ranges near Adelaide (Osborn, 1914, p. 114) one might regard the almost pure groupings of *Stipa* found upon slaty downs north of Broken Hill as attempts to form grassland within typical steppe country.

In the neighbourhood of Euriowie and northwards through Corona, the Archaean gneisses and schists dip unconformably beneath the slates, limestones and claystones of the Pre-Cambrian System.

In these parts interesting junctions may be seen of the two rock types, bearing fairly distinct floras. This is particularly marked near Corona homestead, where there is a junction between an extensive limestone outcrop and a hill of gneisses and schists. On the latter, the mulga scrub association is found, though the number of individuals is considerably less than in typical scrub association. This is no doubt due to grazing and the browsing down of seedlings of woody perennials by both sheep and rabbits.

The limestone flora on the other hand is characterised by the development of a belt of a rare mallee *Eucalyptus Gillesii* J H M (Pl. xvii, fig. 7). The pre-

vious records of the occurrence of this mallee in Australia have been for the Flinders Range in South Australia, Burracoppin in Western Australia and for Eurrowie and Mundi Mundi in the Broken Hill District. It apparently occurs chiefly on limestone outcrops.

W. Gill says of it "It covers scores of acres on the poor hill and rise sides on travertine and chert country and looks like a great blue or silver blanket over the country."

Eucalyptus oleosa is the only other mallee anywhere within hundreds of miles" (Maiden, 1912, p. 177).

In the Barrier Range, *E. Gillii* is restricted to small "pockets" as is true of the other species of mallee in these parts.

In association with *E. Gillii* are occasional migrants from the mulga scrub association of neighbouring rises, but for the most part there is no dense undergrowth of smaller shrubs such as occurs in this latter association. There is a ground flora of numerous species of *Kochia* and *Bassia* such as *K. sedifolia* F v M., *K. pyramidata* Benth., *K. brevifolia* R Br., *K. villosa* Landl., *Bassia diantha* F v M., *Bassia lamcusps* F v M., *B. paradoxa* F v M. and others.

Restricted to regions at the immediate base of *E. Gillii*, and growing in its shade are clumps of *Zygophyllum fruticulosum* D C which make bright green patches against the dull green of the *Kochia*.

Botanical Features of Interest in the Mulga Scrub Association—Despite its density, one of the most noteworthy features of the mulga scrub is the comparative absence of shade. This may be accounted for in the fact that there are but few plants with wide spreading branches, the upwardly directed lateral branches helping to ensure the compact nature of the growth form so prevalent. The nature of the leaves or phyllodia, their reduced form and their vertical lie in relation to light are also responsible for this absence of shade. Drought resistant, xerophytic forms make up the greater part of the ground flora on this account.

Another important feature and one observed by the writer throughout both arid and semi-arid regions, is the localised grouping of numerous plants of one species into a community.

It appears that any one species of the mulga scrub association may be thus localised and often occupy a considerable space of country. This feature has been observed by Dr. Cannon for the hillsides habitat in the Copley District of South Australia (Cannon, 1921, p. 74). The present writer is inclined to believe that this is by no means a local condition, but to be found universally in regions of low rainfall, nor is it a condition restricted to perennials, but occurs freely amongst annuals.

Cannon (1921, p. 74) accounts for this grouping, in the uniformity of environmental conditions over large areas. He observed such "mono-specific" communities of *Eremophila Freelingii* F v M., *Pholcha scoparia* R Br., *Zygophyllum crenatum* F v M., *Cassia Sturtii* R Br., and *Kochia sedifolia* F v M. To this the writer may add numerous examples met with frequently in widely separated localities, the most common being perhaps such additional species of *Cassia* as *Cassia eremophila* A. Cunn. and *C. artemisioides* Gaud., *Heterodendron oleae-folium* Desf., *Acacia Burkittii* F v M., *A. cana* J H M., and various *Chenopodiaceae*. Since all the species met with thus may occur mingled freely in mixed communities, and in the general scrub association, the writer is of the opinion that there is a further factor than that of environmental uniformity causing this condition.

Erratic rainfall, long periods of drought followed by or interrupted by

severe local thunderstorms, soaking rains which influence certain areas of country while leaving others quite dry, might possibly account for the extensive regions often colonised by one species. In a country where seed is known to lie dormant over many years, and where certain species may reappear in profusion after a long interval, it is reasonable to suppose that rainfall and other factors have been at length suitable for extensive germination of seed of that particular species.

The same reason may be held to account for the occurrence of Cannon's "monospecific communities," and one may believe that in some past year, conditions have been suitable for a profuse germination of seed of the particular species forming such a community.

According to the rate of germination of a species in comparison with that of other species, and the percentage of survival of the seedlings, the ultimate configuration of the flora for the particular region in which these species occur, is predestined.

A rate of germination and establishment about equal to that of other species reached by the rains, and a mixed community of the most general type may be the result.

A rate of germination in excess of that of other species together with a greater survival percentage and one may reasonably expect a "monospecific" community.

Once a monospecific community of this kind is well established there would be difficulties in the way of mixing the community by invasion, or by later germination of seeds of other species.

Vegetative propagation from horizontal roots, both in the case of perennials and annuals, may account, in part, for the extent of the areas occupied by "monospecific" communities.

Isolated Species and Small Groupings—In addition to the monospecific communities an interesting feature of this association is the occurrence in it of isolated individuals of certain species, or of small groups up to about a dozen individuals. Cannon says of similar groups observed by him in South Australia (1921, p. 76) "Whether such small communities or isolated individuals represent recent introductions, or survivals from populous mixed communities, are matters of interest but this study throws no light on the problem."

The occurrence of small groups of individuals, at varying intervals, is no doubt due to the method of vegetative propagation so common amongst perennials of arid regions, by forming new shoots from horizontal roots, a short distance beneath the surface.

Various species of *Acacia*, e.g., *A. Loderi* J.H.M., *Hakea leucoptera* R.Br., *Heterodendron oleaeifolium* Desf. afford instances of this.

But the occurrence of certain small, quite isolated groups, or of solitary individuals, which apparently play no part in the general configuration of the flora at the present time, needs some further explanation.

The occasional occurrence of such species of *Eucalyptus* as *E. odorata* Behr. and Schlecht. and *E. transcontinentalis* J.H.M. (mallees), as at Stephen's Creek in association with *E. rostrata* F.v.M., and again of *E. odorata* and *E. intertexta* R.T. Baker at Apollyon Valley, as well as the "pockets" of *Eucalyptus oleosa* in this latter locality, at Thackaringa, and Mt. Robe, might be associated with a time when denudation had not reached its present stage, when rainfall was greater and the vegetation more luxuriant. These regions may be regarded as heirs of a more luxuriant vegetation which have persisted during the pauperisation of the flora with increasing aridity.

The species *Petalostylis labicheoides* R Br (Caesalpinaeae), occurring on the lower slopes of Mt Robe* and *Eriostemon linearis* A. Cunn., on the higher levels of Mt Robe and Moorkai Hill, about 5 miles north of Stephen's Creek Reservoir, occur sparingly in the district, and may be regarded also as possible survivors from less arid times. Another interesting species occurring in scattered groups and isolated individuals throughout the district is *Callitris robusta* R Br. This species attains its largest size in the Barrier District, in creek beds, in association with *Eucalyptus rostrata*, as at Pine Creek, 18 miles south of Broken Hill. It is fairly plentiful on rocky hill-sides, also in a few localities north of Mt Robe, and at Mootwingee. Since the pine has been cut extensively in the past for timber, it is rarely found covering large areas to-day.

The occurrence of an isolated individual such as *Findersia maculosa* F v M (the "Leopard-wood") (Pl xviii, fig 11), a solitary plant which has been seen in the Barrier Range in a valley between Purnamoota and The Paps, may be regarded as a chance invasion from the east, where *Findersia maculosa* reaches a fine development in regions of greater rainfall. As far as the writer is aware, this species has not been recorded further west than the locality mentioned above, it occurs freely in a belt of country about 50 miles east of the Range, however, having been recorded from such stations as Kara, Langawirra and Yancannia.

East of the River Darling, with greater rainfall, *Findersia maculosa* becomes a more abundant component of the scrub. It appears to the writer that many solitary individuals such as this must have been carried over their climatic boundaries and may be regarded as peripheral migrants from their more typical habitats.

The following list contains the chief species of the Mulga scrub association of the rocky hills and slopes habitat †

TREES

<i>Callitris robusta</i> R Br	<i>A. Burkittii</i> F v M
<i>Casuarina lepidophloia</i> F v M	<i>A. aneura</i> F v M
<i>Grevillea striata</i> R Br	<i>Findersia maculosa</i> F v M
<i>Hakea leucoptera</i> R Br	<i>Heterodendron oleaefolium</i> Desf
<i>Santalum lanceolatum</i> R Br	<i>Eucalyptus oleosa</i> F v M (mallee)
<i>Fusanus acuminatus</i> R Br	<i>E. transcontinentalis</i> J H M (mallee)
<i>Exocarpus aphylla</i> R Br	<i>E. odorata</i> Behr and Schlecht (mallee)
<i>Pittosporum phylliracoides</i> D C	<i>E. Giller</i> J. H. M. (mallee)
<i>Acacia Oswaldi</i> F v M	<i>E. intertexta</i> R T Baker
<i>A. Loderi</i> J H M	<i>Myoporum platycarpum</i> R Br
	<i>Eremophila longifolia</i> F v M *

TALL SHRUBS

<i>Acacia aneura</i> F v M	<i>T. aculeata</i> Benth
<i>A. tetragonophylla</i> F v M	<i>Dodonaea viscosa</i> Jacq
<i>A. Carnei</i> J H M.	<i>D. viscosa</i> var <i>spathulata</i> Benth
<i>A. cana</i> J H M.	<i>D. attenuata</i> A Cunn
<i>A. sentis</i> F v M	<i>Heterodendron oleaefolium</i> Desf
<i>A. rigens</i> A Cunn	<i>Jasminum linearis</i> R Br
<i>A. Burkittii</i> F v M	<i>Eremophila longifolia</i> F v M
<i>Cassia eremophila</i> A Cunn	<i>E. oppositifolia</i> R Br
<i>C. artemisioides</i> Gaud	<i>E. alternifolia</i> R Br
<i>Templetonia elegans</i> Sweet	

*Mr A Morris has also collected this species at Mootwingee, towards White Cliffs, growing beneath *Eucalyptus rostrata* in a creek bed.

†Since a census of plants of the Barrier District is being prepared by Mr A Morris, of Broken Hill, it is the intention of the present writer to list only the most typical species.

SMALLER SHRUBS

<i>Atriplex vesicarium</i> Hew	<i>P. petrophila</i> F v M
<i>Kochia pyramidata</i> Benth	<i>Sarcotemma australe</i> R Br
<i>Kochia sedifolia</i> F v M	<i>Marsdenia Leichhardtiana</i> F v M.
<i>Kochia villosa</i> Landl	<i>Solanum Sturtianum</i> F v M.
<i>Kochia appressa</i>	<i>S. nigrum</i> L
<i>Kochia triptera</i> Benth	<i>S. esuriale</i> Landl
<i>K. triptera</i> var <i>eroclada</i> .	<i>S. ellipticum</i> R Br
<i>Enchylaena tomentosa</i> R Br	<i>S. ferocissimum</i> Landl
<i>Ptilotus nobilis</i> F v M	<i>Prostanthera striatiflora</i> F v M
<i>P. obovatus</i> F v M	<i>Eremophila latifolia</i> F v M
<i>Acacia continua</i> Benth	<i>E. Duttoni</i> F v M
<i>Cassia Sturtii</i> R Br	<i>E. maculata</i> F v M
<i>Petalostylis labicheoides</i> R Br	<i>E. Sturtii</i> R Br
<i>Dodonaea lobulata</i> F v M	<i>Phorbia scoparia</i> R Br.
<i>Sida virgata</i> Hook	<i>Isotoma petraea</i> F v M
<i>Lavatera plebeia</i> Sims	<i>Scaevola spinescens</i> R Br
<i>Pimelea simplex</i> F v M	<i>Senecio anethifolius</i> A. Cunn.

GROUND FLORA

<i>Cheilanthes tenuifolia</i> (Burm.) Sw	<i>B. bicuspis</i> F v M
<i>Stipa scabra</i> Landl	<i>B. paradoxa</i> F v M
<i>S. trichophylla</i> Benth	<i>Bassia sclerolaenoides</i> F v M
<i>Aristida arenaria</i> Gaud.	(limestones)
<i>A. calycina</i> R Br	<i>B. divaricata</i> F v M
<i>Pappophorum nigricans</i> R.Br	<i>Zygophyllum fruticulosum</i> D C
<i>Neurachne Mitchelliana</i> Nees	<i>Z. ammophilum</i> F v M
<i>Themeda Forskali</i> Hack	<i>Z. apiculatum</i> F v M
<i>Triodia irritans</i> R Br	<i>Z. iodocarpum</i> F v M
<i>Danthoma paniculata</i> F v M	<i>Sida corrugata</i> Landl
<i>Bassia dactantha</i> F v M	<i>Abutilon</i> spp
<i>B. lamcuspis</i> F v M	

In addition to this are numerous annuals, chiefly of the Chenopodiaceae, Cruciferae, Compositae and Leguminosae, which are more typical of the plains habitat and will be listed for that association.

Vegetation of the Rubble Slopes and Plains.

Where the rocky hills habitat merges into the plains by more or less gradual slopes, the ground surface is covered with a certain amount of talus. A noteworthy feature of these talus slopes is the occurrence, already referred to above, of areas of fragmental quartz and ironstone.

These sheets of quartz and ironstone are continually being broken into smaller fragments and, as a result, areas covered by the white or black rubble often extend far out into the plains. Regions such as this are to be found near The Paps and Eurowie, and are largely developed on Poolamacca, Corona and Nundoorra runs. These may be called, for convenience, the rubble plains, in distinction to the sandy plains to be described later.

The rubble plains are of necessity limited in extent, since they are in process of formation, and are restricted to those regions where large masses of quartz and ironstone are formed.

The fragments are of varying size and angular, the quartz on the one hand being frosted white by the action of wind and sand-blast, the ironstone being reddish black and highly polished by the same agency.

A habitat such as this offers considerable difficulty of establishment for seed-

lings. The intense glare from the glistening white quartz, and from the highly polished ironstone, must increase the temperature in which the seedlings establish themselves. As an indication of the extreme inhospitality of such an environment, there is a very poor flora developed. Indeed for miles one might pass over undulating slopes and plains, colonised by but one species. This is *Kochia brachyptera* F.v.M.*, a small, prostrate plant, which pushes its way between the stony fragments. Its elongated, prostrate stems are red in colour, and bear small sage-green leaves, densely clothed in silky hairs. The reddish colour of the stem veiled by the silky clothing hairs, possibly accounts for the mauve tints given to the slopes colonised by this plant. A notable instance of this occurs a little beyond Old Corona. The intense hairiness of the stem and leaves is possibly a necessary protection against intense insolation.

Where wind has deposited layers of sand over these rubble slopes, seedlings of various annuals are not slow in making their appearance. These are chiefly annual saltbushes such as *Atriplex holocarpum* F.v.M., *A. halimoides* Lindl., *A. angulatum* Benth., *A. campanulatum* Benth., *Bassia dauricata* F.v.M., *B. paradoxa* F.v.M., etc., such Composites as species of *Helipterum*, *Helichrysum*, *Craspedula*, *Calotus* and others which are more typically of the sandy plains habitat.

Should the seasons remain good, these sandy areas are made moderately stable by the establishment of certain perennials such as *Atriplex vesicarium* Hew., *Kochia pyramidata* Benth., *Kochia triptera* Benth., and others, and appear as small patches of vegetation scattered through the sheet of rubble.

With the coming of a dry season, however, the adverseness of this habitat asserts itself, the invaders die out, and the rubble plain becomes once again a wind swept waste.

The Plains

Extending beyond the rubble plains for many miles and completely surrounding the Range are the plains proper. These have been shown (pp. 229-30) to extend in a northerly direction as far as the Grey Range near the Queensland border, east towards the River Darling, and west across the border into South Australia. The plains have a surface covering of red, sandy soil, held by geologists to be the results of denudation of the great Desert Sandstone masses which at one time covered considerably greater areas than at the present day. These sands in places reach a great depth, but in other localities are underlain by a clayey subsoil at no great distance from the surface. In the immediate neighbourhood of the Barrier, the plains areas represent depressions between the spurs of the range, and on this account are not so sandy as the wide expanse of plains surrounding the range. From its most characteristic species in the Western District, *Atriplex vesicarium*, this habitat derives its name of "saltbush plain."

Atriplex vesicarium is a low silvery-grey perennial shrub dotted fairly uniformly over the plains (Plate xx). It is apparently able to withstand long periods of dry weather, though occasionally one comes across large areas of dead plants of *A. vesicarium*, which have no doubt suffered in some prolonged drought. Although in the depression plains noted above there is possibly an accumulation of salts, yet *Atriplex vesicarium* is apparently not restricted to saline flats.

The presence of a long tap-root, such as is known to exist in this species, might indicate that a water-level is tapped in some clayey substratum, so that a sandy habitat is not necessarily evidence of the non-halophytic nature of this plant.

*This plant is described as *Bassia brachyptera* by Mr Anderson in this Part of the Proceedings.

It would be a matter of interest and value in a pastoral country such as Australia, where the perennial saltbushes are of such importance in grazing, to establish the factors limiting the distribution of such a species as *Atriplex vesicarium*.

Certain questions present themselves in relation to this plant. Is it bound by climatic or edaphic ties? Is its presence as a dominant plant over such wide areas merely an indication of a primitive stage in a succession which rarely reaches a more advanced climax, or is its presence a direct response to such a soil factor as the presence of salts in the regions reached by its root system?

The widespread occurrence of *Atriplex vesicarium* in a variety of situations, its dominance over many miles of both sandy and alluvial soils as well as in depressions which undoubtedly possess a certain percentage of salts, seems to support the former view.

Evidence has been brought forward to show that the nature of the rainfall—whether influenced by summer or winter rain controls—affects the dominance of the saltbush amongst the lower shrubs and ground vegetation in Australia. Taylor says (1920, p. 337) "The major portion of the remainder of the region of very erratic rainfall is covered largely by Mulga (*Acacia* sp.) [*Acacia aneura*] interspersed with open salt-bush areas in the south, and with open grasslands in the north. Latitude 23° seems to be the boundary between them at any rate in the central regions, and this recalls the seasonal rainfall control distinguishing the sage-brush from the grass-land regions in U.S.A."

Thus it is seen that the distribution of open saltbush communities accompanying mulga scrub depends upon winter rainfall control, whereas grassland develops in the northern section of the arid zone in response to summer rains. The Barrier District being in a region of winter maximum rainfall, and being a little to the south of the boundary between summer and winter rain controls, comes within the area of saltbush domination. Grasslands, in which the Mitchell Grass (*Distichlis pictinata* F.v.M.) Flinders Grass (*Ischaema Mitchellii* Andr.) and Blue Grass (*Andropogon sericeus* R.Br.) are the most important pastoral grasses, are known to exist beyond the Queensland border in a northerly direction from the Barrier Range. In regions where there is an overlapping of the summer and winter rain controls, there is a mingling of grass with saltbush ground flora. This condition is common in the Grey Range in certain habitats and will be dealt with in a later paper.

In the Barrier Range, occasional grasses are found with *A. vesicarium* on the saltbush plains, but these are often restricted to areas subjected to flooding, and rarely play an important role. The small grass, *Schismus fasciculatus*, which has appeared in the Barrier District within recent years, is an interesting coloniser of waste and eaten-out pastoral lands (Pl. xvii, fig. 8). Forming small closely pressed mats on the surface of the ground, it makes an apparent sward on otherwise bare areas. It seeds profusely, and apparently the seed germinates readily, since this plant responds by profuse germination to repeated falls of rain.

Atriplex vesicarium often assumes complete control over large areas and forms a pure association. More often it is found in association with *Kochia sedifolia* F.v.M., *Kochia pyramidata* Benth., and *Kochia aphylla* R.Br. The two latter species of *Kochia* are larger shrubs and grow into big clumps. In places *Kochia aphylla* and *Rhagodia spinescens* R.Br. cover large areas to the exclusion of other species. The large rounded plants of the latter cover more surface than other species of saltbush and are often over 4 feet in height. At The Overflow,

Corona, the *Koocha-Rhagodia* community extends on to country which is flooded after heavy rains. In this locality, a close carpet-like community of *Marsilia* spp covers the ground (Pl xx, fig 19)

Occasional trees of the saltbush plains such as *Myoporum platycarpum*, species of *Acacia*, *Grevillea struata*, etc, may be regarded as recent migrants from the mulga scrub association of the hills habitat, or, on the other hand, may represent residuals of a previous more luxuriant vegetation in which the plains climax vegetation resembled that of the hills

Annual Flora of the Plains

A striking feature of the plains is the profuse development between the perennial saltbushes of an annual ground flora in response to rains. These annuals are particularly noticeable on regions which have been heavily grazed over, and in these localities they may dominate the plains for many miles.

The chief families represented amongst this ground flora are the Chenopodiaceae (annual saltbushes) Zygophyllaceae, Compositae, Leguminosae, Malvaceae, etc. Many other families are represented by but a few species. The annual saltbushes such as *Atriplex holocarpum* F v M, *A. halimoides* Landl, *A. angustatum* Benth, *A. campanulatum* Benth, *A. limbatum* Benth, *A. Muellera* Benth, etc, are the first species to colonise minor drainage channels, and the edges of roadways and stock routes after rains. These species extend further on to bare land and prepare the way for the later development of Compositae and Leguminosae and other families. The dominance of annual Chenopodiaceae and Compositae amongst the ground flora of the plains can no doubt be accounted for in the efficient means of seed dispersal adopted by these families and the consequent increased capacity for invasion. This capacity for invasion is still further increased owing to the greater fertility known to exist in families which produce only one seed in each flower (Clements, 1916, p. 65).

Amongst the Compositae, species of *Helipterum*, *Helichrysum*, *Craspedia*, *Myriocephalus* and many others make a brilliant display of colour. Almost pure communities are sometimes found extending over many acres. In growth form, this family exhibits great variety, species of *Helipterum*, *Helichrysum*, *Rutidosia*, *Millotia*, *Isoetopsis*, *Angianthus* and others being found in ephemeral or dwarf form, closely-set mat forms in which the capitula are clothed in dense woolly hairs are found in such genera as *Chionocephalus*, while rosette forms are favoured by *Leptorrhynchus*, *Craspedia*, etc.

Amongst the Leguminosae pure communities of the mauve and purple *Swainsona* and the scarlet pea (Sturt's Desert Pea) *Chanthus Dampieri* A. Cunn often replace the Compositae (Plate xix).

Chanthus Dampieri is a prostrate plant, the grey-green leaves and branches of which are clothed in long silky hairs. After a rainy season acres of plains country are ablaze with the large scarlet and black flowers of this species. Apart from the Chenopodiaceae (species of *Bassia*, *Babbagia*, *Arthrocnemum* and *Koocha*) succulence is notably developed in the Portulacaceae amongst the flora of the plains. *Portulaca oleracea* L, a small prostrate annual, and *Calandrinia balonensis* Landl, the bright pink-flowered "parakeelya" with its rosette of rigid succulent leaves, are useful fodder plants on account of their water storage capacity. Sheep have been known to live on the latter plant for weeks without water.

Another succulent species amongst the annual ground flora and a good fodder plant is *Tetragonia expansa* an important coloniser of bare, over-grazed regions.

The following is a list of the chief species of the plains flora. The plants occurring in the clay-pans, crabholes and flooded flats are included in a later list.

Gramineae*

Stipa scabra Lndl
S. elegantissima Labill
Pappophorum nigricans
Danthonia penicillata F v M
Eragrostis falcata Gaud
Panicum melananthum F v M (rare)
Aristida ramosa R Br
Triraphis pungens R Br (rare)
Triraphis mollis var *humilis* R Br
Andropogon amulatus Forsk (rare)
Schizanthus fasciculatus
Hordeum murinum (introduced)
Avena sativa L (introduced)
Astrebula pectinata F v M

Liliaceae

Lilanthus sp }
Bulbine semibarbata Haw } geophytes

Chenopodiaceae

Rhagodia spinescens R Br
Chenopodium nitratum F v M
Atriplex vesicaria How
A. holocarpum F v M
A. halimoides Lndl
A. angulatum Benth
A. Muellieri Benth
A. campanulatum Benth
A. flexuale F v M
Kochia sedifolia F v M
K. aphylla R Br
K. triptera Benth
K. triptera var *crioclada* Benth
K. pyramidata Benth
K. brevifolia R Br
K. appressa Benth
K. ciliaris F v M
K. brachyptera F v M
K. Georgii Dulac
Bassia scleroloboides F v M
B. diacantha F v M
B. bicuspidata F v M
B. quinquecuspidata F v M
B. lanatus F v M
B. longicuspidata F v M
† *B. obliquicuspidata* Anderson
B. biflora F v M
B. bicornis F v M
B. divaricata F v M
B. ventricosa J M B
B. limbata J M B

† *B. intricata* Anderson.

Babbagia acroptera F v M
B. dipterocarpa F v M
Enchylana tomentosa R Br
Arthrocnemum sp
Salsola Kali L
Salsola Kali var *strobilifera* Benth

Amaranthaceae

Ptilotus nobilis F v M
P. obsoletus F v M
Alternanthera nodiflora R Br

Aizoaceae

Tetragonia expansa Murray

Portulacaceae

Portulaca oleracea L
Culandrina balanensis Lndl

Cruciferae

Stenopetalum lineare R Br
Lepidium papillosum F v M
L. fasciculatum
Blennodia lasiocarpa F v M
B. trisetia Benth

Cassulaceae

Tillaea recurva Hook

Leguminosae

Swainsona procumbens F v M
S. lephrotrocha F v M
S. phacifolia F v M
Lotus australis Andrews
Psoralea patens Lndl
Chanthus Dampieri A Cunn

Guttiferaceae

Frodium cygnorum Nees

Oxalidaceae

Oxalis cormiculata L

Zygophyllaceae

Zygophyllum fruticosum D C
Z. ammophilum F v M
Z. iodocarpum F v M
Z. apiculatum F v M
Nitraria Schoeberi Lann

Euphorbiaceae

Euphorbia Drummondii Boiss
E. australis Boiss
E. cretrophila A Cunn

Malvaceae

Sida corrugata Lndl
Lavatera plebeia Sims
Abutilon spp

* The Gramineae were named by Miss E. Reed, B.Sc., Department of Botany, Perth W.A. to whom the writer's thanks are due

† These species are described by Mr Anderson in the present Part of the Proceedings

Frankeniaceae	<i>Minuria</i> sp
<i>Frankenia</i> sp	<i>Calotris hispida</i> F v M
Thymeleaceae	<i>C. erinacea</i> Stütz
<i>Pimelea simplex</i> F v M	<i>Brachycome</i> sp
Umbelliferae	<i>Isotopisma graminifolia</i> Turc (ephemeral)
<i>Didiscus glaucifolius</i> F v M	<i>Myrocephalus</i> Stuarti Benth
<i>Daucus brachiatus</i> Sieber	<i>Vittadina australis</i> A Rich
Convolvulaceae	<i>Angianthus pusillus</i> Benth
<i>Convolvulus erubescens</i> Sims	<i>Gnephosis cyathopappa</i> Benth
Boraginaceae	<i>G. skirrophora</i> Benth
<i>Heliotropium curassavicum</i> L	<i>Rutidosia helichrysoides</i> D C
<i>Lappula concava</i> F v M	<i>Leptorrhynchus squamatus</i> Less
<i>Roechea maccoya</i> F v M	<i>Helipterum strictum</i> Benth
Solanaceae	<i>H. pugmacum</i> Benth (ephemeral)
<i>Solanum esuriale</i> Lindl	<i>H. hyalospermum</i> F v M
<i>S. ellipticum</i> R Br	<i>H. floribundum</i> D C
<i>S. ferocissimum</i> Lindl	<i>H. moschatum</i> Benth
<i>Nicotiana suaveolens</i> Lehm	<i>H. corymbiflorum</i> Schlecht
Goodeniaceae	<i>Helichrysium</i> sp
<i>Goodenia</i> sp	<i>Calocephalus platycephalus</i> Benth
Cucurbitaceae	<i>Craspedia globosa</i> Benth
<i>Cucumis</i> sp	<i>Chenoccephalus</i> sp
Compositae	
<i>Olearia</i> sp	

Clay-Pans, Crab-Holes and Flooded Flats

Within the plains may be recognised certain minor habitats such as the clay-pans, and the smaller circular depressions known locally as "crab-holes" or "gil-gais."

The clay-pans represent shallow depressions in the sandy plain, from which the sandy surface soil has been removed by wind, leaving exposed a hard clayey floor. The pans vary in size from embryonic pans to large areas some miles in diameter. Twin pans occur side by side and, upon the removal of the intervening barrier of sand, these merge into one pan. It is possible that the largest pans have been formed by the merging of neighbouring pans. Being the centres of localised drainage systems within the plains, rain-water collects in the pans and, owing to the hard clayey floor, is unable to percolate away. In medium-sized pans the water may remain for a couple of months while in the largest pans which are regarded as inland lakes, the water may remain for over a year before complete evaporation takes place. Clay-pan country is thus of importance in a pastoral land where water conservation is one of the chief problems. With evaporation the salts collected by the rain-water as it drains off the higher land are deposited on the floor of the pans, together with fine layers of silt. The clayey floor subsequently becomes sunbaked and hardened to such an extent that it offers an effective resistance to invasion.

In dry seasons the pans, for the most part, remain bare and windswept, but after a light fall of rain such *Chenopodiaceae* as *Babbaquia acroptera* F v M. and *Bassia* spp commence colonisation. These two genera represent the pioneer colonisers amongst the *Chenopodiaceae* on hard clayey soils. With colonisation, even though scattered, a certain amount of sand accumulates in the pan around the pioneer colonisers, and this paves the way for a more extensive invasion. Small pans may pass through a complete cycle in this manner, until completely filled in with sand, they are then populated by the typical species of the plains.

The large pans are rarely empty long enough for a complete colonisation to take place. During the recent drought in the Barrier District, however, a large clay-pan lake 100 miles north of Broken Hill, Lake Bancannia (Pl xxiii, fig 25) became completely dry, and colonisation by species of *Bassia* and *Chenopodium* took place. A mixed community of species of *Bassia*, in which *B. divaricata* is dominant, has taken possession of the central portion of the pan, while large clumps of *Chenopodium nitratum* F v M mingled with *Bassia* spp inhabit the outer zones.

The larger clay-pans are often delimited from the surrounding country by a special flood zone which is likely to be inundated after heavy falls of rain, owing to the overflowing of the clay-pan lakes. These are known as flooded flats or "Box" flats from the characteristic tree, the Black Box (*Eucalyptus bicolor* A. Cunn), which forms a distinct belt around the clay-pan (Pl xxii, fig 23, xxiii, fig 24). *Eucalyptus bicolor* is restricted to these flooded flats in the Barrier District and apparently depends for its existence upon periodic inundation. At Lake Bancannia and Lake Cobham (Pl xxiii) the Box Flats had not been inundated for over two years at the time of the writer's visit in October, 1922, and the trees were consequently dying out.

Another species commonly found on these flooded flats and occupying the ground between the Box trees is *Muehlenbeckia Cunninghamii* (Polygonaceae) the "lignum." *Muehlenbeckia Cunninghamii* is a leafless shrub with long intertwining branches. In places it forms impenetrable thickets, and may reach a height of over six feet. It is a species associated with flooded and swampy country throughout the western district of New South Wales.

A ground flora develops upon these flooded zones in which species of *Marsilia*, the "Nardoo," (Pl xx, fig 19) often form pure communities, spreading over many acres. *Marsilia Drummondii* and the diminutive *Marsilia exarata* A. Braun are commonly found in the Barrier District. Colonising wet soil either with *Marsilia* or forming pure communities is the small Composite, *Centipeda thespidioides* F v M. *Mimulus repens* R Br forms flat mats on drier soil, while *Morgana glabra* R Br, *Lavatera plebeia*, *Lappula concava* F v M., *Linum marginale* A. Cunn., *Wahlenbergia* sp and Compositae such as *Helipterum floribundum* D C., *H. corymbiflorum* Schlecht, *Anquithus pusillus* Benth and many others occupy the outer fringes of the flooded areas.

The crab-holes or "gilgais" are small circular depressions in which water lodges after rain. Certain investigators hold that these depressions are hollowed out by the "willy willy" winds (Pittman, p 465) while others believe that they are due to surface subsidence, following the consolidation of alluvials below (Jose Taylor and Woolnough, 1911, p. 122). The crab-holes are colonised by plants of the flooded flats habitat just described. Being small localised areas, they may pass through a complete successional cycle, commencing with wet soil forms such as *Marsilia* and *Centipeda*, and ultimately reaching a final stage of Composites and grasses, merging into the plains flora. Occasionally a final stage in the colonisation of the crab-holes is characterised by a bright green clover which stands out in striking contrast to the prevailing grey-green of the surrounding plains flora. At other times, the "gilgai pea," *Swainsona prorumbens*, makes pleasing patches of colour in the crab-holes, with its masses of deep purple flowers. The following is a list of the chief plants of the clay-pans, crab-holes and flooded flats.

Filices	Cruciferae
<i>Marsilia Drummondii</i>	<i>Blennodia</i> spp
<i>Marsilia exarata</i> A Braun	Leguminosae
* Gramineae	<i>Psoralea patens</i> Landl
<i>Eragrostis imbecilla</i> Benth (rare)	<i>Swainsona procumbens</i> F v M
<i>E. lacunaria</i> F v M	Zygophyllaceae
<i>Dryeuza quadrifida</i> Benth	<i>Nitraria Schoeberi</i> Linn
<i>Bromus arenarius</i> Labill	<i>Zygophyllum</i> sp
<i>Hordeum murinum</i> Linn	Malvaceae
<i>Chloris ventricosa</i> var <i>tenuis</i> R Br	<i>Lavatera plebeia</i> Sims
Amaryllidaceae	Myrtaceae
<i>Crinum flaccidum</i> Herbert	<i>Eucalyptus bicolor</i> A Cunn
Polygonaceae	Campanulaceae
<i>Muehlenbeckia Cunninghamii</i> F v M	<i>Wahlenbergia gracilis</i> D C
Chenopodiaceae	Boraginaceae
<i>Atriplex umbatum</i> Benth	<i>Lappula concava</i> F v M
<i>A. campanulatum</i> Benth	<i>Rochelia maccoya</i> F v M
<i>A. angulatum</i> Benth	Solanaceae
<i>A. holocarpum</i> F v M	<i>Nicotiana suaveolens</i> Lchm
<i>A. halimoides</i> Landl	Scrophulariaceae
<i>Bassia darwinata</i> F v M	<i>Mimulus repens</i> R Br
<i>B. lanatus</i> F v M	<i>Morgana glabra</i> R Br
<i>Babbagia dipterocarpa</i> F v M	Compositae
<i>B. acroptera</i> F v M	<i>Centipeda thespidioides</i> F v M
<i>Chenopodium nitrariaceum</i> F v M	<i>Anquithus pusillus</i> Benth
<i>Enchylarna tomentosa</i> R Br	<i>Helipterum floribundum</i> D C
Aizoaceae	<i>H. corymbiflorum</i> Schlecht
<i>Tetragonia expansa</i> Murray	<i>H. stipitatum</i> F v M
Papaveraceae	<i>Cotula coronopifolia</i> L
<i>Glaucium flavum</i> (introduced)	
Linaceae	
<i>Linum marginale</i> A Cunn	

The Vegetation of the Creeks

The general monotony of the plains is relieved by the lines of trees marking the meandering courses of the creeks.

Eucalyptus rostrata F v M, the River Red Gum (Pl. xvii, fig. 22), is the characteristic tree of these creeks and is a species apparently well suited to drier regions, since it is found in similar situations throughout arid Australia. Although the creeks in these localities are nothing more than sandy channels, in which water runs only for a short time after heavy falls of rain, the water relations are nevertheless good, since this is the only habitat bearing large trees.

Cannon has shown that the main portion of the root-system of *Eucalyptus rostrata* is "made up of large horizontal members which may extend for a long distance from the central stem. Thus the superficial roots of *Eucalyptus* were seen to reach out nine meters or more and to lie at a depth not exceeding 60 cm" (Cannon, 1921, p. 62).

Although the development of a superficial root-system may be regarded as a response to the characteristic rainfall of arid regions, yet it seems probable, in the case of *Eucalyptus rostrata* at least, that some subterranean water level is tapped by the main vertical root. This seems the more likely when we take into consideration the lengthy periods of drought, when the surface layers of the soil are hardly moistened at all.

In addition to *Eucalyptus rostrata*, other trees such as *Paltotheca phyllifera*, *Ficus acuminata* and more frequently species of *Acacia*, such as *A. senilis* and *A. Burkittii*, inhabit the creeks. Certain tall shrubs of the hills habitat border the creeks occasionally, particularly where these leave the hills and enter upon the plains.

Heterodendron oleaeifolium reaches a fine tree growth in such situations.

The sandy flats which extend back from the creeks to the plains, and are occasionally subjected to flooding, are generally colonised by species of *Atriplex*, *Kochia* and *Rhagodia* and eventually merge into the plains habitat. In certain localities a white alkaline scum is deposited on the surface of the soil after the falling back of flood waters. This alkali has been found to contain magnesium, sodium and lime sulphate, chloride and carbonate (Mawson, 1912, p. 223).

In such places the "Sodabush," *Nitraria Schoeberi*, occurs abundantly, forming large rounded bushes. With *Nitraria*, species of *Zygophyllum* are often found.

Minor drainage channels are bordered by pioneer Chenopodiaceae, annual species of *Atriplex* predominating. These are followed by perennials such as *Atriplex vesicarium*, *Kochia pyramidalis*, *Kochia aphylla* and *Rhagodia spinescens*. A shrubby Composite—*Senecio magnificus*, the broom-like *Templetonia elegans* and the annual *Psoralea patens* are common in such situations.

On a small creek on Corona at the northern limit of the Range, the "paper-bark tea tree," *McLaleuca parviflora* Lndl., was found in association with a few young trees of *Eucalyptus rostrata*.

This is the only locality in the Barrier District where this species was observed by the writer.

As a general rule the first tree growth bordering young creeks is of various species of *Acacia*, *Acacia senilis* and *Acacia Burkittii* being important pioneers. An interesting plant of the sandy creek beds and rocky ledges bordering the creeks is the orange-flowered Amaryllid, *Crinum flaccidum* Herb. This species is one of the few geophytes of the district, and perennates by means of a bulb sometimes placed at a distance of over a foot beneath the soil surface. Within a week after a fall of rain, the red sandy soil of the creek beds and flooded zones is turned to a vivid green by the young leaves of *Crinum* bursting through the soil. This plant forms large seeds which are unprotected by a coat other than a thin layer of cork and, not having any special means of dispersal, germinate almost immediately. It is quite usual to find numerous germinating seeds of *Crinum* lying on the surface of the sand.

The cotyledon remains attached to the fleshy seed by means of a sucker which transfers food from the seed to the young plant (Rendle, 1904, p. 305). At quite an early stage the base of the cotyledonary sheath becomes thickened to form the first bulb scale and eventually, by elongation of the sheathing portion of the cotyledon, the plumule and the young bulb are carried beneath the surface of the soil. In this manner *Crinum* overcomes the disability of a naked seed by forming a special organ of perennation, a bulb, during the germination period, and still further by burying the bulb thus formed.

Vegetation of the Sandhills

As has been shown above, there are large areas in the Barrier District covered with drifting sand. This sand is of the same nature as that of the sandy plains, and is thought to have been derived by the wearing down of the Desert Sandstones of Cretaceous Age.

Stages may be observed in the formation of sandhills, from small, transitory hummocks, through mobile small dunes, to the more stable fixed sand-ridge, with its climax vegetation. The latter is developed extensively in the northern part of the region and extends across to the Lake Eyre Basin in South Australia.

As this sand-ridge climax will be dealt with more fully in the second part of this series, it is intended here only briefly to describe the flora of the small, mobile dunes in the immediate neighbourhood of the Range.

Since these small dunes are unstable in formation and plant covering, and since their flora merges appreciably into that of the plains, they might be regarded as a minor habitat within the plains.

The pioneer colonisers on these small sandhills are *Salsola Kal* and its variety *S. Kal* var. *strobilifera*. *Salsola Kal* is the "jolly-polly" of the arid regions of Australia and is well suited to dispersal by wind, the whole plant being snapped off at the base and tumbled over the plains. An interesting evidence of the dispersal of this species is to be found at the border fence between South Australia and New South Wales, where old plants of *Salsola* are piled high against the wire netting. *Salsola Kal* appears to favour the lower slopes of the dune during the early stages of its colonisation, but later advances up the slopes and occupies considerable areas.

For the main part, the flora of these small sandhills is of the annual type developed upon the sandy plains. Being localised areas often of small extent, they are sometimes colonised exclusively by one species. *Myriocephalus Stuartii* and other Compositae sometimes completely invade young dunes.

The occurrence of species not previously met on the plains, such as the shrubby *Acacia legulata* and the broom-like *Crotalaria dissitiflora*, indicates some betterment of the water relations in this habitat.

Amongst the annual species, the Compositae, Leguminosae, Malvaceae, Solanaceae, Portulacaceae and Gramineae are well represented, and resemble closely the annual flora of the plains. Occasional new species are met, however, which are apparently limited to sandhills. These are notably the rigid *Aisoon quadrifidum* F.v.M. with its small succulent water-storing leaves, and the large prostrate hairy *Psoralea eryanthe* Benth. which forms spreading mat-like colonies.

That these dunes are still in a developmental stage is indicated by the almost complete absence from them of any tall shrubby or tree vegetation and the preponderance of annuals amongst the ground flora. Later, the dunes become larger and more stable and a climax vegetation is reached similar to that described for the hills habitat, in which species of *Acacia*, *Eremophila* and *Casuarina* play an important role.

GENERAL DISCUSSION

As has been shown above, the vegetation of the Barrier Range is of two main types—that of the rocky hills and slopes, and that of the plains. The vegetation of the former habitat is mulga scrub, in which *Acacia aneura* is dominant and is associated with other species of *Acacia*, *Eremophila*, *Dodonaea*, *Hakea*, etc. Occasional communities of *Casuarina lepidophloea* (oak), *Eucalyptus oleosa* (mallee) and *Callitris robusta* (pine) occur within this association.

The plant covering of the plains is for the most part of open communities of *Atriplex vesicarium* (the saltbush), with which *Kochia aphylla* (bluebush), *Kochia aphylla* (cottonbush), *K. pyramidata* and *Rhagodia spinescens* are often associated. Any of these species may assume the role of co-dominant with *Atriplex vesicarium*.

An annual flora made up chiefly of Compositae, Cruciferae, Papilionaceae and others appears on the plains after good rains. Within the plains association, minor habitats may be recognised, such as rubble slopes and plains, clay-pans, gilgais, gum-creeks, flooded flats and small mobile dunes.

The rubble slopes and small dunes represent primary bare areas within the plains and, being but sparingly colonised and in the latter case primarily by annuals, they often revert to their original bare condition with the coming of a drought.

The clay-pans, gilgais and flooded flats are subjected to changing conditions according to whether the season is rainy or dry, and consequently rarely reach a stabilised condition of vegetation. The gum-creeks on the other hand represent better water relations and bear a vegetation of tall trees (*Eucalyptus rostrata*) and shrubs (*Acacia* spp.).

The Barrier District has been largely devoted to the pastoral industry during the past 50 to 75 years and thus, together with the fact that the rabbit has become an established pest, must be considered as contributing, in part, to the present day configuration of the vegetation. The combined effect of sheep and rabbits helps to check the natural development of vegetation. This must have occurred to a great extent in the early days of the grazing industry when overstocking of runs was the rule. Overstocking, particularly when followed by drought, causes large secondary bare areas, from which the natural vegetation has been eaten out. In a continued drought, these areas become windswept wastes, the surface soil is often removed, leaving exposed a hard clayey substratum which becomes compacted and hardened by windswept particles. Such areas are particularly inhospitable to the invasion and establishment of seedlings and thus regeneration of vegetation is retarded. The extensive burrowing of rabbits, the browsing down of seedlings and the ring-barking of woody perennials near the burrows are also responsible for secondary bare areas in scrub or plains.

Since the saltbush (*Atriplex vesicarium*) and the mulga (*Acacia aneura*) are amongst the chief fodder plants of the district and represent the mainstay of stock during long droughts, it seems possible that grazing may have played a large part in preventing the development of the vegetation beyond the mulga scrub association on the one hand, and the saltbush association on the other. The browsing down of seedlings, the ring-barking of young woody perennials and the wholesale eating of seed in times of drought by stock and rabbits must also play some part in arresting the development of vegetation in these parts.

As far as our present knowledge goes, *Acacia* scrub is the most extensively developed and the most characteristic vegetation of the hilly regions in the Barrier District, while the saltbush association is that of the plains. Further evidence should be obtained, however, from widely separated localities, before we can fairly judge whether these represent true climax associations for the particular climatic region involved. The occurrence of small groupings or communities of tree vegetation, in the scrub association, such as that of the mallees (*Eucalyptus oleosa*) at Mt. Robe, and *E. odorata* and *E. transcontinentalis* at Apollyon Valley, and of the pine, *Callitris robusta* (Mootwingee) and the oak, *Casuarina lepidophloea* (Thackaringa) points to the possibility of a potential climax more advanced than that existing over the greater area of the Barrier Range to-day. Either these communities are to be regarded as representing attempts at the further development of the vegetation from a mulga scrub pre-climax, or they represent residuals of a more luxuriant vegetation associated in former times with less arid conditions. Since the region under investigation is one of increasing aridity within recent geological times, the latter view appears the more probable.

Evidences of succession in the Barrier District are but few. Where secondary bare areas occur in mulga scrub owing to clearing, burning, and dying out of communities during droughts, these are colonised by Chenopodiaceae such as *Atriplex vesicarium*, *Kochia sedifolia*, *K. pyramidata*, *Enchylasma tomentosa*, etc. In rare cases earlier stages of colonisation of secondary bare areas are observable, species of *Bassia* always appearing before the larger species of *Atriplex* and *Kochia*. At various localities, and particularly as seen by the writer at Corona on rocky hills a pure association of *Bassia* makes up the ground flora, the chief species being *Bassia divaricata*, *B. lanceusps*, *B. bicusps* and *B. diacantha* with *B. paradoxa* on the lower slopes (Plate xv)

The Chenopodiaceae are apparently the pioneer colonisers on all bare ground in the Barrier District, whether of primary or secondary origin. The rubble slopes and plains described above are often colonised exclusively by one species, *Kochia brachyptera*, and rarely reach a more advanced stage of development. Bare clay-pans and clayey flats subject to flooding are colonised in the pioneer stages by species of *Bassia* and *Babbagia*, followed later, in one instance at least, by *Chenopodium nitratum* (Pl. xxiii, fig. 25)

Early colonisation of dunes takes place by *Salsola Kal*, while all drainage channels and minor watercourses are first invaded by annual species of *Atriplex*.

On the limestone slopes of the Torrowangee Series, where only scattered members of the mulga scrub are represented, species of *Kochia* are pioneer colonisers, *Kochia sedifolia* being the dominant species in the open community which results (Pl. xvii, fig. 9). Low undulating slate outcrops are also colonised by open communities of *Kochia* (Pl. xvii, fig. 8).

From these facts it would appear probable that the saltbush association of the plains represents an early stage in succession, prevented from further development by biotic as well as climatic factors. The occurrence of members of the saltbush association upon secondary bare areas within the mulga scrub association points to the developmental relationship of these two associations.

Of the various types of vegetation investigated by Dr Cannon in South Australia, that of Copley in the Flinders Range (1921, p. 64) resembles most closely that of the Barrier Range in New South Wales. This is to be expected, since not only is the Barrier Range regarded by geologists as being of similar age and as representing an easterly extension of the Flinders Range, but climatically the regions are alike. Copley is shown to have an average annual rainfall of 8.40 inches, while Broken Hill the chief town of the Barrier Range has 10 inches. The Copley District again resembles the Barrier in its position with regard to the summer and winter rain controls and in the variability of its rainfall.

The vegetation of the Copley District resembles that of the Barrier in that there is a distinct scrub on rocky hills, in which species of *Cassia*, *Eremophila* and *Acacia* are important. The vegetation of the plains is made up chiefly of Chenopodiaceae with species of *Atriplex* and *Kochia* dominant. Cannon refers to the two genera *Cassia* and *Eremophila* as being probably the most typical genera near Copley, and refers to the association of the hills as the *Cassia-Eremophila* community (1921, p. 73). This appears to be the main point of difference between the scrub of Copley and that of the Barrier Range where species of *Acacia* are dominant.

In order to establish truly the relationships of the vegetation of the Barrier District with those of other parts of arid Australia, and to gain a truer conception of the successional development and the nature of climax vegetation in this region, it would be necessary to enclose and make stock and rabbit proof a large area of hills and plains country. Until this is carried out on a sufficiently large

scale, it will not be possible to judge fairly of the natural development of this vegetation, whether progressive or retrograde, nor of its future possibilities as an economic asset

SUMMARY

- 1 Physiographic units of New South Wales are described with especial reference to the nature and formation of the Great Western Plains
- 2 The classification of arid regions is briefly discussed, and the suggestion made that "climax" vegetation should be used as a basis of classification
- 3 Certain features of rainfall affecting the arid regions of Australia are dealt with and an account given of the geologic, physiographic and climatic features of the Barrier Range
- 4 The plant associations of various habitats in the Barrier District are discussed and lists of the most representative species given
- 5 The most important of these are the Mulga Scrub association of the rocky hills and slopes and the Saltbush association of the plains
- 6 Minor habitats such as rubble slopes, clay-pans and crab-holes, flooded flats, gum-creeks and sandhills are described, and an account given of their plant covering
- 7 In a general discussion the developmental aspect of the vegetation of the Barrier District is dealt with and comparisons made with the arid flora of other parts of Australia

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EXPLANATION OF PLATES XV-XXIII

The writer has to thank Miss E. Reed, B.Sc., University of Western Australia for the photographs reproduced in figs 3, 8, 9, 10 and 19, Miss D. Nobes, B.Sc., for those in figs 5, 7 and 18, and Mr A. Morris, of Broken Hill for that in fig 11.

Plate xv

Fig 1—Group of mulgas (*Acacia aneura*) on rocky hill at Corona, north of Broken Hill. Ground vegetation made up of species of *Bassia*.

Fig 2—*Acacia tetragonophylla* ("Dead-finish") Ground flora—species of *Bassia*.

Fig 3—Low hills near Corona with open mulga scrub. Corona creek with *Eucalyptus rostrata* in middle distance.

Plate xvi

Fig 4—*Sarcostemma australe* ("snake-bush" or "caustic-bush"), a leafless Asclepiad growing on rocky slopes. Broken Hill.

Fig 5—*Isotoma petraea* growing in clefts and between gneissic boulders. Broken Hill.

Fig 6—*Prostanthera striatiflora* with *Aristida* and *Philotus obovatus* in right foreground, illustrating the nature of the lower shrubs and undergrowth of the Mulga scrub association. Broken Hill.

Plate xvii

Fig 7—Low limestone hill with scattered mallee (*Eucalyptus Gilleri*), ground flora made up entirely of species of *Kochia* and *Bassia* with *Zygophyllum fruticosum* at the base of the trees. Corona.

Fig 8—Slate outcrops near Old Corona on main stock route. Sparse vegetation of *Kochia sedifolia* and *K. pyramidata* with ground covering of the grass, *Schismus fasciculatus*. Rubble sheet of fragmental quartz uncolonised.

Fig 9—Limestone slope near Corona with open community of species of *Kochia*. The trees near summit of slope are *Casuarina lepidophloia*.

Plate xviii

Fig 10—Mulga-dotted slopes near Corona with old mulga in foreground infected with *Uromycladum*.

Fig 11—Solitary tree of *Flindersia maculosa* (Leopard-wood) with ground flora of *Kochia sedifolia*. Between Purnamoota and The Paps, Barrier Range.

Fig 12—Flooded clayey flat behind creek showing colonisation by species of *Bassia*.

Plate xix

Fig 13—Level sandy ground showing plants of *Ceanothus Dampieri* (Sturt's Desert Pea). Broken Hill.

Fig 14—Single plant of *Ceanothus Dampieri* indicating prostrate habit and manner of growth.

Fig 15—*Bassia paradoxa* colonising bare clayey soil between flood levels on a sandy creek.

Plate xx

Fig 16—Depression in the Range between Broken Hill and Thackaringa—the Pinnacles in the distance—colonised chiefly by *Atriplex vesicarium* with *Kochia sedifolia* on higher ground.

Fig 17—*Atriplex vesicarium* (Saltbush) plain with a few trees of *Acacia* sp. and gum-creek (*Eucalyptus rostrata*) winding in distance.

Fig 18—Typical barren hill close to Broken Hill. *Kochia pyramidata*, *Kochia triptera* and *K. sedifolia* and a few species of *Bassia* represent the only vegetation on the slopes and level ground and indicate dearth of annual vegetation during the 1932 season. Note uncolonised rubble area.

Fig 19—Saltbush plain with *Kochia aphylla* in the foreground and *Rhagodia spinescens* further away. Level ground between shrubs covered with close mat-like colony of *Marsilia Drummondii* (Nardoo)

Plate xxi

Fig 20—Colony of *Triodia irritans* ("Porcupine grass" or "spintex") near Stephen's Creek, Broken Hill

Fig 21—Single plant of *Triodia irritans* showing the formation of a typical hummock by the retaining of sand

Plate xxii

Fig 22—Stephen's Creek, near Broken Hill showing sandy bed and tall gums *Eucalyptus rostrata*)

Fig 23—Clay-pan lake bordered by black Box flat (*Eucalyptus bicolor*) Langawirra

Plate xxiii

Fig 24—Cobham Lake, a large clay-pan north of Broken Hill. Drought-stricken trees of *Eucalyptus bicolor* in foreground

Fig 25—Dry floor of Bancannia Lake, a clay-pan 100 miles north of Broken Hill—showing colonisation by *Bassia divaricata* and *Chenopodium nitratum*.

A MONOGRAPH OF THE FRESHWATER ENTOMOSTRACA OF
NEW SOUTH WALES PART III OSTRACODA.

By MARGUERITE HENRY, B.Sc., Linnean Macleay Fellow of the Society in Zoology

(Plates xxiv-xxix.)

[Read 27th June, 1923]

Introduction

The first description of Ostracods collected in New South Wales was published in 1855 by the Rev R L King who described briefly thirteen new species and a new genus, *Newnhamia*. In 1886 G S Brady described eight species, four of which were new, from the Tweed River district, these descriptions, as well as King's, were based entirely on external features. In 1896 Sars described four new species and redescribed some of the earlier species. One new species was described by the present writer in 1919. The present paper comprises thirty-six species, two of these are recorded for the first time in Australia, one for the first time in New South Wales and seven are described as new.

The records of Ostracods present in the other States are very scanty. In Queensland, seven species were recorded by Sars in 1889, with one exception these occur also in New South Wales.

Brady described three species from South Australia in 1886 and two others are here recorded for the first time. Two species were described from Western Australia in 1896 by Sars.

No records can be found of the species occurring in Victoria or Tasmania.

The writer wishes to express her best thanks to Mr T. Steel for the use of a collection of Ostracods from England and Scotland for comparison with the Australian forms and for shells of two species of *Candona* from the Tweed River. Thanks are also due to Miss M. Collins, B.Sc., for samples of dried mud from the Cobar district, one of which yielded a new species of *Cypridopsis*, and also to many friends who have collected material.

The drawings for this paper were all done with the aid of a camera lucida, the finished drawings were prepared by Miss D. Harrison.

The type specimens of the new species have been deposited in the Australian Museum, Sydney.

The following lists give the Ostracoda recorded from the different States

New South Wales.

CYPRIDIDAE

Subfamily NOTODROMADINAE—*Notodromus fuscatus* Brady, *Newnhamia fenestrata* King

Subfamily ILYOCYPRINAE—*Ilyocypris australiensis* Sars

Subfamily CYPRIDOPINAE—*Cypridopsis funebris* Brady, *Cypridopsis australis*, n sp

Subfamily CYPRIDINAE—*Cypris bonnelong* King, *C. reticulata* Zaddach, *C. clarki* King, *C. scotti* King, *C. lateraria* King, *Cypris crinita*, n sp, *Cyprinotus dentato-marginatus* (Baird), *Cy fuscus* Henry, *Cy incongruens* Ramdohr, *Cy carinatus* (King), *Cy leanus* Sars, *Cy tenuis*, n sp, *Stenocypris malcolmsoni* (Brady), *Cypretta munna* (King), *Cypretta globulus* Sars, *Cypretta turgida* Sars, *Cypretta viridis* Thomson, *Cypretta hirsuta*, n sp

Subfamily CYCLOCYPRIDINAE—*Cypris pusilla* Sars, *Cyclocypris tenuissima*, n sp

Subfamily HERPETOCYPRIDINAE—*Candonocypris candonoides* (King), *Herpetocypris laevissima*, n sp, *Ilyodromus varrovillius* (King), *I viridulus* Brady, *I substriatus* Sars, *I ellipticus* Sars, *I obtusus* Sars, *I stanleyanus* (King).

Subfamily CANDONINAE—*Candona lutra* King, *Candonopsis tenuis* (Brady)

CYTHRIDAE—*Lamnicythere aspera*, n sp

Queensland

CYPRIDIDAE

Subfamily CYPRIDINAE—*Cyprinotus dentato-marginatus* (Baird), *Cyprinotus cingalensis* Brady, *Cypretta globulus* Sars, *Stenocypris malcolmsoni* (Brady)

Subfamily HERPETOCYPRIDINAE—*Candonocypris candonoides* (King), *Ilyodromus viridulus* Brady

Subfamily ILYOCYPRINAE—*Ilyocypris australiensis* Sars

South Australia

CYPRIDIDAE

Subfamily CYPRIDINAE—*Cypris tatei* Brady, *C mytiloides* Brady, *C bonnelong* King, *Cypretta viridis* Thomson

Subfamily HERPETOCYPRIDINAE—*Ilyodromus stanleyanus* (King).

Western Australia

CYPRIDIDAE

Subfamily CYPRIDINAE—*Amphicypris oblongata* Sars, *Cyprinotus dalli* Sars.

Classification

The Ostracoda are divided into four great tribes; three of these possess a biramous antenna variously developed and, so far as is known, are exclusively marine. The tribe *Podocopa* comprises all the freshwater forms and, in addition, a large number of marine forms, they are distinguished by the possession of a simple antenna which always bears apical claws.

Key to families of Podocopa.

A Two pairs of legs, antenna without a flagellum

B Abdomen without a furca *Darwinulidae*.
(not known in Australia).

- BB. Abdomen with a furca *Cyprididae*.
 AA. Three pairs of legs, antenna with a flagellum *Cytheridae*

Family CYPRIDIDAE.

Shell usually thin, surface smooth, striated or pitted. Antennules composed of seven segments. Antennae composed of four to six segments, without a flagellum, with or without a brush of swimming setae. Two dissimilar pairs of legs. Caudal rami usually well developed, sometimes rudimentary. Seven subfamilies are represented in New South Wales.

Key to subfamilies of Cyprididae.

- A Antennae with natatory setae
 B Natatory setae long, at least reaching the tips of the terminal claws
 C Natatory setae reaching the tips of the claws or slightly beyond
 D Second foot with three terminal setae of different lengths
 E Two eyes present *Notodromadinae*
 EE One eye *Ilyocyprinae*
 DD Second foot with a beak-like end segment and a claw
 E Furca rudimentary *Cypridopsinae*
 EE Furca normal *Cypridinae*
 CC Natatory setae exceeding the terminal claws by half their length
 *Cyclocypridinae*
 BB Natatory setae shortened, not nearly reaching the tips of the terminal claws *Herpetocypridinae*
 AA Antennae without natatory setae *Candoninae*

Subfamily NOTODROMADINAE

Shells usually short and high. Natatory setae of the antennae slightly exceeding the tips of the terminal claws. Second leg with three terminal setae of different lengths, one seta reflexed. Two eyes present.

Two genera are represented in New South Wales.

Key to genera of Notodromadinae

- A Second maxilla with two branchial filaments attached directly to the limb *Newnhamia*
 A1 Second maxilla without branchial filaments *Notodromus*

Genus NOTODROMUS Lilljeborg, 1853.

Shell short and high, with a ventral flattening. Antennae composed of six segments. Furca with three seta-like claws, terminal seta absent. Both sexes present. Six species are known, one occurs in New South Wales.

NOTODROMUS FUSCATUS Brady

This species was described by Brady in 1896 (p. 92, Plate x, figs 4-6) but since merely the external appearance was described it is impossible to decide whether it is a true *Notodromus* or a member of the allied genus *Newnhamia*. Brady's description is as follows. "Shell seen laterally sub-triangular, height equal to three-fourths the length, extremities broadly rounded, anterior narrower of the two, dorsal margin excessively arched, highest a little behind the middle,

ventral nearly straight, seen from above the outline is ovate, scarcely twice as long as broad, tapered and acuminate in front, rounded off behind. Surface of the valves somewhat rough and furfuraceous, colour brownish with darker cloudings."

Distribution—Brady's specimens were collected in the Condong District, Tweed River, N.S.W.

The late Mr G. I. Playfair made drawings of specimens from Lismore, N.S.W., which seem to be identical with those from the Tweed.

Genus *NEUWHAMIA* King, 1855

Shell granulate or tuberculate, appendages like those of *Notodromus* except that the mandibular palp bears a small branchial appendage, the filaments of which are directed upwards, the second pair of maxillae have two branchial filaments attached directly to the limb. Propagation sexual. Only two species are known. *N. patagonica* Vávra from Patagonia and *N. fenestrata* King from Australia.

Neuhamia fenestrata King (Plate xxiv, figs 1-10)

King, Proc. Roy. Soc. Van Diemen's Land, 1855, p. 67.

Female Shell seen laterally (fig. 1) short and high, the greatest height occurring about the middle, dorsal margin arched rather abruptly behind the eye, ventral straight for the great part of its length, becoming rounded off at each end, anterior and posterior margins slightly curved. Viewed dorsally (fig. 2), the outline is broadly ovate, tapering anteriorly with the greatest width, which exceeds two-thirds of the length, situated behind the middle. Ventral surface with a long flattened ventral plate (fig. 5). Valves unequal, the right slightly larger than the left. Surface thickly covered with tubercles, the margins bearing scattered hairs (figs 3-4). Caudal rami (fig. 7) bearing three long seta-like claws, the two terminal ones almost equal in length, terminal seta absent. Colour dark grey to brown. Length, 79 mm., height, 61 mm.

Male Smaller than the female, shell differently shaped, the highest point being behind the middle.

Distribution—This species is common in the neighbourhood of Sydney; it is usually found in permanent ponds and in great numbers. N.S.W.: Sydney, Narrabeen, Lane Cove, Liverpool, Moss Vale, Holbrook.

Brady recorded it from New Zealand in 1906 and incorrectly stated that King's specimens were from Tasmania. Vávra also found it in the Bismarck Archipelago.

Subfamily ILYOCYPRINAE.

Shell strong, surface rough, with grooves and tubercles resembling the members of the family *Cytheridae*. Setae of antennae of varying lengths, usually extending at least to the tips of the terminal claws. Second leg with three setae on the terminal segment, one seta reflexed. One genus, *Ilyocypris*.

Genus *ILYOCYPRIS* Brady and Norman, 1889.

Shell compressed, surface pitted or tuberculate. Second pair of maxillae with a well developed branchial lamella. First leg only composed of five segments. Caudal rami with the dorsal seta attached almost in the middle. Propagation sexual. Seventeen species have been described, one of which occurs in New South Wales.

ILYOCYPRIS AUSTRALIENSIS Sars

Described in detail by Sars (1889) and fully figured (Plate ii, figs. 5-8, Pl. vi, figs. 1-14).

Distribution.—Sars' specimens were raised from dried mud collected at the Gracemere lagoon, near Rockhampton, Queensland. A few specimens were found in a collection from Holbrook. It has not hitherto been recorded from New South Wales.

Subfamily CYPRIDOPSINAE

Natatory setae of the antennae reaching to the tips of the terminal claws. Second leg beak-shaped at the tip, with a terminal claw. Furca rudimentary, terminating in a long seta.

One genus represented in New South Wales.

Genus CYPRIDOPSIS Brady, 1868

Shell tumid. Antennae composed of five segments. Furca rudimentary, ending in a long seta and with a short seta on the dorsal edge.

Several species have been described from Australia and New Zealand as belonging to this genus, but in all except one case they were found to possess a normally developed furca.

Cypridopsis funebris Brady is a doubtful species. The first certain species of *Cypridopsis* in Australia is here recorded for the first time.

CYPRIDOPSIS AUSTRALIS, n.sp. (Plate xxv, figs. 1-7)

Female. Seen laterally (fig. 1) somewhat oval in outline, dorsal margin boldly arched, with a longer slope anteriorly than posteriorly, ventral margin distinctly sinuated just behind the middle, anterior and posterior margins evenly curved, the anterior lower than the posterior, greatest height occurring in front of the middle. Seen dorsally (fig. 2), elongated oval, slightly more pointed anteriorly than posteriorly, greatest width equal to half the length and occurring about the middle. Valves thick and strong, slightly unequal, the left being larger than the right. Surface irregularly marked by rounded pits (fig. 3) and bearing scattered hairs. Antennules with moderately long swimming setae. Antennae (fig. 4) with the setae of the second last segment exceeding the length of the strong terminal claws. First leg (fig. 5) with a strong terminal claw the distal half of which is denticulated. Second leg (fig. 6) bearing a straight terminal claw and a slender seta. Furca (fig. 7) rudimentary, with a small dorsal seta and a long terminal flagellum. Colour brown, becoming grey in alcohol. Length, .61 mm., height, .37 mm.

Distribution.—This species was bred from dried mud collected at Merynla station, near Cobar, N.S.W.

CYPRIDOPSIS FUNEBRIS Brady

This species was described by Brady in 1866 (p. 91, Plate viii., figs. 7-9). The description is only of the shape of the shell which appears to have been immature. Without examining the furca it is impossible to state whether this form is a true *Cypridopsis* and it is even more doubtful since Brady includes *Cyprætta minus* King in this genus. The specimens were collected in the Condong district, Tweed River, N.E.W., N.S.W. Sydney

Subfamily CYPRIDINAE

Natatory setae of the antennae reaching at least to the tips of the terminal claws. Second leg with a beak-like end segment and claw. Furca well developed, usually armed with both claws and setae. Three genera are represented in New South Wales.

Key to genera of Cypridinae

- | | | |
|----|--|----------------------|
| A | Furca with two long terminal setae replacing the usual claws | <i>Cypretta</i> . |
| AA | Furca with claws and setae | |
| B | Dorsal seta of furca rudimentary or absent | <i>Stenocypris</i> . |
| BB | Dorsal seta well developed | <i>Cypris</i> |

Genus CYPRETTA Vavra, 1895

Shell short and tumid. Natatory setae of the antennae reaching beyond the terminal claws. Furca with the terminal claws replaced by setae, usual terminal seta sometimes absent. Ovary spirally wound. Males unknown. Five species occur in New South Wales.

Key to species of Cypretta.

- | | | |
|----|--|------------------|
| A | Surface of the shell distinctly marked by closely set pits | |
| B | Furca with three long terminal setae | <i>globulus</i> |
| BB | Furca with two long setae | <i>hirsuta</i> |
| AA | Surface of the shell smooth or with a few scattered pits | |
| B | Right valve projecting over the left dorsally | <i>minna</i> . |
| BB | Valves even dorsally | |
| C | Width not exceeding three-quarters of the length | <i>viridis</i> . |
| CC | Width almost equal to the length | <i>turgida</i> . |

CYPRETTA GLOBULUS Sars

Cypridopsis globulus Sars, 1889 (Pl II, figs 9, 10; Pl VII, figs 1-11)

Distribution—N S W Five Dock, Kensington, Kendall, Holbrook, Queensland

The average length of this species is 75 mm. Some very much larger specimens were obtained from Five Dock, these attained a length of 90 mm, but were otherwise identical with the smaller forms.

CYPRETTA HIRSUTA, n sp (Plate xxviii, figs. 1-5)

Female. Seen laterally (fig 1) irregularly oval in outline, the greatest height exceeding two-thirds of the length and occurring just behind the middle, dorsal margin evenly arched, ventral straight, anterior rounded, posterior lower than the anterior and almost angular. Seen dorsally (fig. 2) broadly oval in outline, greatest width slightly greater than the height and occurring about the middle, anterior end obtusely pointed, posterior rounded. Surface of the shell distinctly pitted and everywhere densely hairy. Right valve slightly overlapping the left, the ends marked with transverse lines (fig. 3); Muller (1898) regards these as septa which are extended between the valve lamellae for support; they appear to be characteristic of the genus and are especially distinct in this species. Mouth parts typical of the subfamily. Second pair of legs (fig. 4) provided with a hook and a slender recurved seta. Third pair of legs long and slender, apical

seta usually long, second seta not attaining half the length of the first; both apical and dorsal minute setae present. Colour dark green with two lighter patches.

Length, 88 mm, height, 61 mm, width, .63 mm

Distribution—N S W., Kosciuszko

CYPRETTA TURGIDA Sars

Described by Sars in 1894 (Plate iv, fig 3a-d) as *Cypridopsis minna* and renamed *Cypridopsis turgida* in 1896

Female Shell, seen laterally, somewhat semicircular in shape, the greatest height occurring behind the middle and equal to two-thirds the length, dorsal margin boldly arched, sloping more steeply posteriorly than anteriorly, ventral margin straight, anterior and posterior ends rounded. Viewed dorsally, the anterior end is narrower than the posterior but the general shape is almost circular, the greatest width nearly equalling the length. Valves unequal, the right being slightly larger than the left and overlapping it anteriorly. Surface smooth, with a few small pits, hairs almost confined to the extremities. Caudal rami long and narrow, with terminal claw-like setae. Colour light yellowish-brown. Length, 90 mm

Distribution—N S W. Sydney, Moss Vale, Berrima, Holbrook, New Zealand, China; Madagascar, Sumatra.

CYPRETTA VIRIDIS Thomson

Described in 1878 (Plate vi, figs A2a-9) as *Cypris viridis*

Female Seen laterally, rounded oval in form, dorsal margin arched, sloping steeply anteriorly, ventral margin straight, anterior margin lower than the posterior. Seen dorsally, oval in outline with the anterior end narrower than the posterior, width slightly greater than the height.

Valves unequal, the right being larger than the left. Surface smooth with a few scattered pits; densely covered with hairs. Caudal rami slender, with long setae. Colour dark green with irregular patches of a still darker shade. Length, .95 mm

Distribution—N S W. Botany, South Australia, New Zealand

CYPRETTA MINNA (King)

Described as *Cypris minna* in 1855 (p 64), transferred to the genus *Cypridopsis* by Brady in 1886, described and figured by Sars in 1896 (Plate vii, fig. 5a-c) as *Cypridopsis minna*

Female Shell, seen laterally, rounded triangular in shape, the greatest height occurring about the middle and almost equal to the length, dorsal margin angular in the middle, sloping steeply to either side, ventral margin sinuated in the middle. Seen dorsally, somewhat egg-shaped, the greatest width not quite equalling the height. Valves unequal, the right overlapping the left anteriorly and dorsally. Surface slightly granular and hairy. Caudal ram very narrow, setae long. Length Sars gives 92 mm. as the greatest length attained, but many specimens have been found measuring as much as 10 mm and thus is accordingly the largest Australian *Cypretta*. Colour, yellowish with large vivid green patches which become peacock blue in alcohol.

Distribution—N S W. Sydney, Varroville, Denham Court, Centennial Park,

Lane Cove, Condong district, Tweed River Many specimens were bred out of dried mud collected at Meryula station, near Cobar

Genus *STENOCYPRIS* Sars, 1889.

Shell narrow, the height not nearly attaining half the length Natatory setae of the antennae not exceeding the tips of the terminal claws First maxilla with a narrow cylindrical palp, last joint very small, masticatory lobes long and narrow Caudal rami large, claws coarsely denticulate, dorsal seta absent or very small Propagation sexual

Nineteen species have been described, one of which occurs in New South Wales

STENOCYPRIS MALCOLMSONII (Brady)

Syn *Cypris cylindrica* Baird

Described in 1886 (p 297) as *Cypris malcolmsonii* and made the type of a new genus by Sars in 1889 (Pl 1, figs 7, 8, Pl v, figs 1-4)

Female Shell, seen laterally, elongated and narrow, height uniform, not nearly attaining half the length, dorsal margin straight for the greater part of its length, sloping abruptly in front and behind, ventral margin distinctly sinuated in front of the middle, anterior and posterior margins rounded Seen dorsally, very narrow, with straight sides, anterior end more pointed than posterior Valves almost equal, the left slightly longer than the right, inner duplicatures broad Caudal rami strong, unequal, the right broader than the left and bearing a row of strong denticles, left ramus tapering slightly and bearing few small denticles, both claws coarsely denticulate, dorsal seta absent Length, 1.7 mm. Colour pale green

Distribution—N S W Casino, Queensland, India, Ceylon

Genus *CYPRIS* Muller

Shell of various shapes Antennae composed of five segments, natatory setae reaching to the tips of the terminal claws or beyond Furca well developed, bearing claws and setae Propagation sexual or parthenogenetic

This large genus has been divided into a number of subgenera; two are represented in New South Wales

Key to subgenera of Cypris

- | | | |
|---|-----------|-------------------|
| A Inner edge of the right shell thickly tuberculate | . | <i>Cyprinotus</i> |
| AA Inner edge plain | | <i>Cypris</i> . |

Subgenus CYPRIS

First leg five-segmented Inner edge of the right valve not tuberculate
Furca normal with two claws and two setae

Key to species of subgenus Cypris

- | | | |
|---|-----------|-------------------|
| A Length not attaining 3 mm | | |
| B. Shell with a prominent anterior flange | | <i>bennelong.</i> |
| BB No such flange | | |
| C Surface of the shell sculptured | | |
| D Shell armed with tubercles | | <i>lateraria.</i> |

DD	Shell without tubercles	<i>reticulata</i>
CC	Surface of the shell smooth	<i>crinita</i>
AA	Length exceeding 3 mm	<i>scottii</i>

CYPRIS BENNELONG King

Syn *Chlamydotheca australis* Brady

Described very briefly by King in 1855 (p 63) from an immature specimen. In 1894 (Pl iv, figs 1a-d) Sars described the same species from New Zealand and, on examining immature forms, decided that it was identical with the form described by King. Although the shell has the flange that is characteristic of the genus *Chlamydotheca*, the structure of the oral parts shows it to be a true *Cypris*, the natatory setae of the antennae extending well beyond the tips of the terminal claws.

Female. Shell, seen laterally, oval triangular, the greatest height exceeding half the length and occurring about the middle, dorsal margin arched, sloping more steeply anteriorly than posteriorly, ventral margin with two slight sinuses, anterior margin rounded, projecting into a flange at the lower corner, the prominence being caused by the left valve considerably overlapping the right. Seen dorsally the outline is oblong, with the greatest width equal to half the length, sides nearly straight, anterior end narrower than posterior, with a peculiar twist formed by the projection of the left valve. Surface smooth, margins of the valves hairy. Natatory setae of the antennae projecting far beyond the terminal claws. Caudal rami long and slender, apical claw equalling half the length of the ramus. Length, 1.4 mm. Colour brownish-green.

Distribution.—N.S.W. Sydney Cove, Bourke Street, Corona, South Australia, New Zealand.

CYPRIS LATERARIA King

Described by King in 1855 (p 65, Plate x, G)

Female. Shell, seen laterally, much higher anteriorly than posteriorly, the greatest height slightly greater than half the length; anterior margin rounded, posterior obliquely truncated, dorsal arched above the eye, thence sloping in a straight line to the posterior margin, ventral margin deeply sinuated about the middle. Seen dorsally the shell appears oval, more pointed anteriorly than posteriorly, the greatest breadth equalling the height. Left valve larger than the right, overlapping it anteriorly and posteriorly; inner duplicatures narrow. Surface of the shell granular and densely hairy, bearing tubercles. Caudal rami slightly narrowed towards the tips, the outer claw not attaining half the length of the ramus. Colour yellowish-green. Length, 1.05 mm, height, .63 mm.

Distribution.—N.S.W. Bourke Street, Sydney, Bringagee

This species was reared from dried mud from Bringagee and from Corona

CYPRIS RETICULATA Zaddach.

Zaddach, Synopses crustaceorum Prussicorum Prodomus, 1844, p 34

Female. Shell, seen laterally, with the greatest height occurring in front of the middle, dorsal margin arched especially in the anterior portion; ventral margin with a slight sinuation behind the middle, anterior and posterior margins rounded. Seen dorsally, broadly oval, the greatest width occurring about the middle, anterior end narrower than the posterior. Natatory setae of the antennae reaching slightly beyond the tips of the terminal claws. Surface of the shell sculptured with a fine reticulation which is more distinct in younger speci-

mens. Caudal ramus bent near the apex, terminal claws denticulate, terminal and dorsal setae of equal length. Length, 1.3 mm. Colour yellowish to brown with dark markings.

Distribution—N S W. Holbrook, North America, Europe.

* This is the first record of the occurrence of this species in Australia. The specimens examined agreed exactly with the descriptions of European forms, the only difference being a darker coloration.

CYPRIS CRINITA, n. sp. (Plate xxvi, figs 1-8)

Female (fig. 1). Shell, seen laterally, irregularly oval in outline, the greatest height exceeding half the length and occurring slightly in front of the middle; dorsal margin arched, sloping evenly at each end, ventral margin gently curved sinuated in the middle, anterior and posterior margins evenly curved, the anterior lower than the posterior. Seen dorsally (fig. 3) a regular oval, except at each end, where there is a projection of the left valve, greatest width occurring about the middle and not quite equalling the height. Valves unequal, the left overlapping the right anteriorly, posteriorly and ventrally. Surface smooth, except for the usual small scattered pits, anterior and ventral margins bearing hairs, those of the posterior margin being unusually long. Antennules (fig. 4) with moderately long setae. Antennae (fig. 5) with the setae of the antepenultimate segment easily exceeding the tips of the terminal claws. First leg (fig. 6) with a powerful curved terminal claw bearing a row of denticles. Caudal ramus (fig. 8) very long and exceptionally slender, terminal claw almost as long as the ramus, second claw only one-third as long as the terminal one, both claws denticulate and straight except for a pronounced hook at the end, terminal seta slightly shorter than the dorsal. Colour brilliant green and orange. Length, 2.2 mm, height, 1.2 mm, width, 1.1 mm.

Male (Fig. 2). Smaller than the female, the largest found only attaining a length of 1.9 mm. Shape somewhat different from that of the female, the height being greater in comparison with the length, the dorsal margin more pronouncedly arched and the ventral margin straighter.

Distribution—N S W. Holbrook.

CYPRIS SCOTTII King

This species has not been recorded since King very briefly described it in 1855 (p. 63, Plate x, fig. C). It is evidently distinct from any other species recorded in Australia, since King describes it as being "nearly the tenth of an inch in length, of a transparent green colour marked with very minute reddish spots." The locality given is Denham Court.

CYPRIS STOBARTI King

Described by King (1855, p. 62, Plate ix, Fig. B) from a single specimen which was not dissected. It is impossible to decide from the description whether this is a true *Cypris*, its outline suggests the subfamily *Herpetocypridinae*. King's description is as follows—"The shell is oblong and slightly sinuated on the posterior dorsal margin. The valves are unequal, the left being the larger. They are polished and apparently of a yellowish colour."

Distribution.—Queensland. Moreton Bay.

CYPRIS CLARKII King.

This species also suggests the *Herpetocypridinae* but until further specimens are obtained it is impossible to decide whether it is a true *Cypris*. King's description (1855, p. 63, Plate x, E) only gives colour and form "Shell oval, slightly reniform, the valves very convex, variegated with brown and a light reddish green in well defined notches of irregular but constant shape, the eye is yellow, shell punctured pilose"

Distribution—N S W Sydney, Parramatta.

Subgenus CYPRINOTUS Brady, 1885

Shells usually high, the greatest height being more than half the length, inner margin of the right valve thickly tuberculate. Brady described *Cyprinotus* as a new genus in 1885 (p. 301) with *C. cingalensis* as the type species, the inequality of the valves being taken as a generic character, in this species the right valve is gibbous and overlaps the left valve dorsally. In 1889 Sars described *C. dentato-marginatus* from Queensland, this species obviously belongs to the same genus as *C. cingalensis*, but lacks the dorsal projection of the right valve. Sars therefore based the genus on the tuberculate right valve and the fact that the propagation was sexual as contrasted with the genus *Cypris* which was supposed to be exclusively parthenogenetic. In 1903, Sharpe reduced *Cyprinotus* to a subgenus of *Cypris*, distinguished by the possession of tubercles on the right valve margin. He pointed out that the method of propagation is not always a generic character among the Ostracoda and that there are genuine species of *Cypris*, such as *C. testudinaria*, which propagate sexually. In this paper two species described by Sars under the genus *Cypris* have been transferred to the subgenus *Cyprinotus*, their males are unknown but there is no proof that they are exclusively parthenogenetic although they are known to propagate in this manner under certain circumstances.

Key to species of the subgenus Cyprinotus

- A Surface smooth and polished
 - B Right valve forming a dorsal projection
 - C Right valve considerably overlapping the left ventrally . . . *fuscus*
 - CC. Valves even ventrally . . . *carinata*
 - BB No dorsal projection of the right valve
 - C Length exceeding 2 mm . . . *leana*
 - CC Length not attaining 2 mm
 - D Greatest height occurring in the middle . . . *dentato-marginatus*
 - DD Greatest height occurring posterior to the middle . . . *incongruens*
- AA Surface marked by a reticulate pattern . . . *tenax*

CYPRINOTUS FUSCUS Henry

Proc Roy Soc N.S.W., 1919, p. 44. Plate 11., figs. 13, 14

Distribution—N.S.W. Botany, Lismore

CYPRINOTUS CARINATA King

Described in 1855 (p. 61, Pl. ix, figs. C1-4) as *Cypris carinata*. The brief description and the figures are characteristic of this subgenus, the shape of the shell somewhat resembles *C. cingalensis*, although the dorsal projection is situated

farther back on the shell King's description is as follows:—"Shell nearly elliptical, but higher on the back, the valves are unequal, the right being produced beyond the left at the posterior part of the dorsal edge giving the shell the appearance of a bell, the valves are polished, of a transparent greenish colour, with a darker quadrangular mark in the middle. Males darker and somewhat smaller"

Distribution—Denham Court

CYPRINOTUS LEANA Sars

Described in 1896 (Plate vii, figs 2, a-c) as *Cypris leana*.

Female Shell, seen laterally, oval reniform, the greatest height occurring at the middle, dorsal margin greatly arched, ventral almost straight, anterior margin rounded, posterior higher than the anterior and obliquely truncated. Seen dorsally, oval in shape, the greatest width occurring behind the middle and equaling half the length, more pointed anteriorly than posteriorly. Valves slightly unequal, the right valve bearing a row of tubercles on the anterior margin and on the posterior portion of the ventral margin. Inner duplicatures narrow. Surface of the shell smooth and polished, the ends bearing small hairs. Caudal ramus slender, tapering distally, apical claw equaling half the length of the ramus. Colour yellowish-brown. Length, 2.7 mm.

Distribution—Hay, Yass

CYPRINOTUS DENTATO-MARGINATUS (Baird)

Described in 1859 (p. 233) as *Cypris dentato-marginatus*. Fully described and figured in detail by Sars in 1889 (Pl. i, figs 1-4, Pl. iii, figs 1-11, Pl. iv, figs 1-14).

Distribution.—N S W. Botany, Centennial Park, Queensland, India; Ceylon.

CYPRINOTUS INCONGRUENS Ramdohr

Syn *C. sydnæa* King, *C. ciliata* Thomson

First described by Ramdohr in 1808 (p. 83), described by King in 1855 (p. 65) as *Cypris sydnæa* and figured by Sars under that name in 1894 (Plate iv, figs 2 a-c).

Female Shell, seen laterally, reniform, higher posteriorly than anteriorly, the greatest height occurring behind the middle and exceeding half the length; dorsal margin curved, with a longer slope in front than behind, ventral margin almost straight. Seen dorsally, somewhat oval, much broader posteriorly than anteriorly, breadth not as great as the height. Left valve larger than the right, overlapping it at each end and ventrally, right valve tuberculated along the anterior margin and postero-ventrally. Surface smooth and polished with a few scattered pits. Caudal ramus curved, apical claw not nearly half as long as the ramus. Colour yellow to orange. Length, 1.4 mm.

Distribution.—This is one of the few Ostracods with a world-wide distribution. It is common in the neighbourhood of Sydney and specimens have been collected at Bangalow on the North Coast of New South Wales. It has been recorded from New Zealand, North America, Europe and Asia.

CYPRINOTUS TENUIS, n. sp. (Plate xxvii, figs 1-3.)

Female (fig. 1) Seen laterally, irregularly oval in outline, with the

greatest height occurring in front of the middle. Dorsal margin arched, sloping more abruptly anteriorly than posteriorly; ventral margin straight, anterior and posterior margins truncated, the anterior higher than the posterior. Seen dorsally (fig 2) elongated oval, the greatest width occurring behind the middle, the sides curving to the posterior end but tapering to the more pointed anterior end. Valves unequal, the left being larger than the right, right valve bearing a row of denticles on its anterior margin and also on the postero-ventral corner, inner duplicatures narrow. Surface of the shell covered with an irregular reticulate pattern, with diamond-shaped meshes enclosing numerous small pits (fig 3). Antennules (fig 5) bearing long swimming setae, those of the antennae (fig 4) reaching beyond the terminal claws. Second leg (fig 7) bearing a short curved claw and a long seta. Caudal ramus (fig 8) comparatively short, terminal claw equal to three-quarters the length of the ramus, second claw slightly shorter, neither claw bearing denticles, apical seta short, only attaining half the length of the dorsal seta. Colour greyish brown, very transparent in alcohol. Length, 1.1 mm, height, .59 mm.

This species somewhat resembles *C. pellucida* Sharpe, an important difference is that in *C. pellucida* the right valve is larger than the left, whereas in the present form the exact opposite occurs.

Distribution—N.S.W. Kensington

Subfamily CYCLOCYPRIDINAE

Natatory setae of the antennae very long, exceeding the terminal claws by about half their length. Second leg with three setae of different length, one or more reflexed. Furca normal.

Key to genera of Cyclocypridinae

- A Terminal segment of the second leg small, with two short setae and a long reflexed seta *Cypria*
- AA Terminal segment of the second leg long, with one short claw and two reflexed setae *Cyclocypris*

Genus CYPRIA Zenker, 1854.

Shell short and high, strongly compressed. Second antenna of the male with two sense organs on the fourth segment. Last segment of the second leg short, bearing two short claw-like setae and one long reflexed seta. One species occurs in New South Wales.

CYPRIA PUBILLA Sars.

Described in 1896 (Plate VII, figs 1a, b)

Female. Shell, seen laterally, somewhat semicircular in outline, the greatest height occurring about the middle, posterior margin rounded, higher than the anterior which is oblique; dorsal margin boldly arched, ventral almost straight. Seen dorsally, oblong, the anterior end slightly narrower than the posterior. Valves unequal, the right slightly overlapping the left anteriorly and postero-ventrally, and projecting much more dorsally. Surface of the shell smooth, margins densely hairy. Colour reddish-brown. Length, .58 mm.

Distribution—N.S.W. Rarely found in stagnant pools in the vicinity of Sydney. Sars' specimens were collected at Waterloo.

Genus CYCLOCYPRIS Brady and Norman, 1889

Second antenna of the male without sense organs on the fourth segment. Terminal segment of the second leg long and narrow, bearing a short claw-like seta and two long reflexed setae. About fourteen species have been described.

CYCLOCYPRIS TENUISSIMA, n sp (Plate xxix, figs 1-3)

Female (fig 2) Shell, seen laterally, oval in outline, dorsal margin evenly curved, ventral distinctly sinuated behind the middle, anterior margin curved, higher than the posterior, greatest height occurring in front of the middle and equal to slightly more than half the length. Seen dorsally, broadly oval, more pointed anteriorly than posteriorly, greatest width occurring behind the middle. Valves slightly unequal, the left overlapping the right anteriorly and posteriorly. Surface granular, though not definitely sculptured, free margins sparsely hairy. Natatory setae of the antennules and antennae very long. Second leg with a moderately long end-segment bearing a short claw-like seta and two reflexed setae, one of which is nearly twice as long as the other. Caudal rami (fig 3) long and slender, curved, end-claws long. Dorsal seta almost equal to the apical seta in length. Colour brown. Length, 52 mm, height, 28 mm.

Male (fig 1) Slightly smaller than the female and higher in proportion to its length; dorsal margin more boldly arched, ventral almost straight. Length, 50 mm., height, 30 mm.

Distribution—N S W Orange

Subfamily HERPETOCYPRIDINAE

Natatory setae of the antennae shortened. Second leg terminating in a beak-shaped end-segment armed with a short claw. Incapable of swimming in the adult state. Three genera are represented in New South Wales.

Key to genera of Herpetocypridinae

- | | |
|-------------------------------------|-------------------------|
| A Furca normal | |
| B Left valve larger than the right | . <i>Herpetocypris</i> |
| BB Right valve larger than the left | . <i>Candonocypris</i> |
| AA Furca ending in three claws | . . . <i>Ilyodromus</i> |

Genus CANDONOCYPRIS Sars, 1894

Shell oblong, height not attaining half the length. Right valve overlapping the left. Natatory setae of the antennae not attaining the tips of the terminal claws. First pair of maxillae with short masticatory lobes, palp large, bearing a few claw-like spines. Propagation usually parthenogenetic.

One species occurs in New South Wales.

CANDONOCYPRIS CANDONOIDES (King)

Described by King in 1855 (p 66) as *Cypris candonoides*. Redescribed and figured in detail by Sars in 1889 (p 35, Plate II, figs 1-2, Pl V, figs 5-7) as *Herpetocypris stanleyana*. Transferred to a new genus *Candonocypris* by Sars in 1894.

Distribution—N S W Sydney, Varroville, Buckanbe; Queensland; New Zealand, South Africa.

Genus *HERPETOCYPRIS* Brady and Norman, 1889

Shell elongated. Natatory setae of the antennae not attaining the tips of the terminal claws. Second segment of the first leg with one seta on the anterior margin. Maxillae as in *Cypris*. One species present in New South Wales.

HERPETOCYPRIS LAEVISSIMA, n. sp. (Plate xxviii, figs 6, 7)

Female (fig 6) Seen laterally, oval in outline, with the greatest height, which slightly exceeds half the length, situated behind the middle. Dorsal margin arched, sloping more abruptly posteriorly than anteriorly; ventral margin distinctly sinuated about the middle, anterior and posterior margins rounded, the anterior being lower than the posterior. Seen dorsally, regularly oval in outline, with the greatest width occurring about the middle, anterior end more pointed than the posterior. Valves equal, margins sparsely hairy. Surface of the shell smooth, except for a few scattered and very tiny pits. Antennules with moderately long setae. Antennae with very short setae which do not reach beyond the base of the terminal claws. Second leg ending in a curved claw and bearing a long seta. Caudal ramus (fig 7) long and slender, second claw attaining two-thirds the length of the apical claw, both minutely denticulated, setae of equal length, dorsal edge of the ramus bearing a row of minute denticles. Colour greenish-yellow. Length, 1.4 mm, height, .72 mm.

Male unknown.

Distribution—N. S. W. Parramatta.

Genus *ILYODROMUS* Sars, 1898

Shells highly compressed. Valves equal or the left valve larger than the right, inner duplicatures very broad. Natatory setae of the antennae poorly developed. Caudal rami armed with three claws increasing in length distally.

Males unknown.

Six species occur in New South Wales.

Key to species of Ilyodromus

- A Surface marked by distinct longitudinal lines
- B Ventral margins of the valves almost straight . . . *stanleyanus*
- BB Ventral margins deeply sinuated
 - C Greatest height not nearly equal to half length . . . Length exceeding 1.5 mm . . . *varrovillius*
 - CC Greatest height almost equal to half the length . . . Length less than 1.5 mm . . . *obtusius*
- AA Surface smooth or delicately striated
 - B Surface quite smooth *viridulus*
 - BB Surface striated
 - C Dorsal margin forming an angle above the eye . . . *substriatus*
 - CC Dorsal margin evenly curved . . . *ellipticus*

ILYODROMUS STANLEYANUS (King)

Described by King in 1855 (p. 86) as *Candona stanleyana*. In 1886 (p. 89) Brady described *Cypris stanleyana* from an immature specimen, it is doubtful whether this is identical with King's species. Sars figured this species in 1894 (Plate v, figs. 8a-e) and transferred it to the genus *Ilyodromus*.

Female Shell, seen laterally, elongated reniform in shape, dorsal margin

straight in the middle, sloping at each end, ventral slightly sinuated in the middle, anterior and posterior margins rounded and equal in height. Seen dorsally, very compressed, more pointed anteriorly than posteriorly. Left valve very slightly larger than the right, overlapping at each end and ventrally; inner duplicatures very broad. Surface of the shell sculptured with elevated longitudinal lines, with small scattered pits between them. Caudal rami strongly built, of uniform breadth, claws well developed. Colour dark green. Length, 1.6 mm.

Distribution—N S W. Coogee, Maroubra, South Australia, New Zealand.

ILYODROMUS VARROVILLIUS (King)

(*Cypris varrovillius* King, 1855 (p. 41), *Ilyodromus varrovillius* Sars, 1894 (p. 41, Plate vi., figs. 1a-c))

Female. Shell, seen laterally, narrow and somewhat oblong in shape, dorsal margin straight for the greater part of its length, sloping anteriorly and posteriorly, ventral margin sinuated in front of the middle, posterior rounded, lower than the rounded anterior margin. Seen dorsally, moderately compressed, oval in outline. Valves and surface of the shell as in the preceding species. Caudal rami coarsely built, expanded at the tips, claws well developed. Colour deep green. Length, 1.6 mm.

Distribution—N S W. Bourke Street, Varroville, Kendall, Holbrook; New Zealand.

ILYODROMUS OBTUSUS Sars

Sars, 1894, p. 46, Plate vi., figs. 4a-d

Female. Shell, seen laterally, reniform, with the greatest height almost attaining half the length so that this species is comparatively higher than the two preceding species, dorsal margin very straight, sloping at each end, ventral margin deeply sinuated at the middle, extremities obtusely rounded and of equal height. Seen dorsally, oval in outline, moderately compressed. Surface and relative size of the valves as in *I. stanleyanus*. Caudal rami strongly built, dilated at the tips, claws well developed. Colour dark green. Length, 1.4 mm.

Distribution—This species has not before been recorded in Australia. Several specimens were obtained at Leura on the Blue Mountains. Sars' specimens were reared from dried mud collected at Dunedin, New Zealand.

ILYODROMUS VIRIDULUS (Brady)

Briefly described as *Cypris viridula* by Brady in 1886 (p. 88). Fully described and figured by Sars in 1896 (Plate ii., figs. 3, 4; Plate v., figs. 8-11) as *Herpetocypris viridulus*. Transferred to the genus *Ilyodromus* by Sars in 1896.

Distribution—N S W. Bourke Street, Sydney, Condong district, Parramatta, Queensland.

ILYODROMUS SUBSTRIATUS Sars

Videns Sels. Skrifter: Math. Nat. Klasse, 1894, No. 5 (p. 45, plate vi., figs. 3a-c)

Female. Shell, seen laterally, of irregular reniform shape; dorsal margin slightly curved, angular above the eye, ventral margin distinctly sinuated, posterior margin rounded, very much higher than the anterior. Seen dorsally, moderately compressed, elongated oval in shape. Valves unequal, the left being considerably larger than the right and overlapping it at both ends and ventrally.

inner duplicatures broader anteriorly than posteriorly. Surface of the shell marked by delicate longitudinal lines, not nearly so conspicuous as in *I stanleyanus*. Caudal ramus well developed, claws short and strong. Colour light yellowish-green. Length, 1.5 mm.

Distribution—N S W Sydney, Botany, New Zealand

ILYODROMUS ELLIPTICUS Sars

Sars, 1896 (Plate vii, figs 4a-c)

Female Shell, seen laterally, elliptical; dorsal margin very slightly arched; ventral almost straight, anterior and posterior margins rounded and of equal height. Seen dorsally, very much compressed, elongated oval in shape with the anterior end more pointed than the posterior. Valves almost equal, the left very little larger than the right. Surface faintly striated, ends hairy, the hairs being long and far apart on the posterior margin. Caudal ramus with well developed claws. Colour yellow tinged with green. Length, 1.1 mm on an average, specimens collected at Lane Cove attained a length of 1.5 mm.

Distribution—N S W Bourke Street, Botany, Lane Cove

Subfamily CANDONINAE

Antennae composed of five segments in the female and usually six in the male. Natatory setae absent. Terminal segment of the second leg bearing three unlike setae, two of which are backwardly directed. The members of this family have lost the power of swimming and are found creeping in the mud or on water plants. Two genera are represented in New South Wales.

Key to genera of Candoninae

A Furca normal	<i>Candona</i>
AA Furca without a dorsal seta	<i>Candonopsis</i>

Genus CANDONA Baird, 1850

Antennae of the female composed of five segments, of the male six. Second pair of legs five, sometimes six, segmented, with two backwardly directed unequal setae and one long forwardly directed seta. Furca normal. Males numerous.

Only one species of this large genus is known to occur in New South Wales.

CANDONA LUTEA King

King, 1855, p. 67, Brady, 1886, p. 92, Plate x., figs 7, 8, Pl. viii., figs 10, 11.

Female Shell seen laterally, subreniform, greatest height occurring behind the middle and equalling half the length; dorsal margin moderately arched, sloping more abruptly posteriorly than anteriorly; ventral distinctly sinuated in the middle; anterior end rounded, posterior much higher and obliquely rounded. Seen dorsally, compressed, elongated oval in outline, the width equalling one-third of the length, anterior end more pointed than the posterior. Valves equal. Surface of the shell smooth and polished. Colour dark green, dried shells, glistening white. Length, 1.3 mm.

King's description of this species is very brief and the only mention of the

appendages is the statement that the antennae lack natatory setae. Brady's description is based on dried shells and unfortunately these were the only specimens available in the present case.

Distribution—N S W. Sydney Cove, Condong district, Tweed River.

Genus CANDONOPSIS Vávra, 1891

Antennae as in *Candona*. Mandible with a very long palp. Furca slender and without a dorsal seta. Ten species have been described, one occurs in New South Wales.

CANDONOPSIS TENUIS (Brady)

Candona tenuis, Brady, Proc. Zool. Soc., 1886, p. 92—*Candonopsis tenuis*, Sars, 1896 (Pl. VII, figs. 6a-d).

Female. Shell, seen laterally, reniform, the greatest height equalling half the length and occurring behind the middle, dorsal margin fairly straight, ventral sinuated, anterior margin lower than the posterior. Seen dorsally, very compressed, anterior end more pointed than the posterior. Valves equal, inner duplicatures broad, ends bearing delicate hairs. Surface smooth and polished, minutely reticulated. Caudal ram narrow, dorsal seta absent, each terminal claw with a denticle situated at half its length. Colour white. Length, 90 μ m.

Male. Dorsal margin arched, ventral sinus occurring in front of the middle, anterior end more produced than in the female. Length, 100 μ m.

Distribution—N S W. Bourke Street, Maroubra, Tweed River, Sumatra.

Family CYTHERIDAE

Surface of the shell usually rough and uneven. Antennules composed of 5-7 segments, not adapted for swimming. Antennae composed of 4-5 segments, the first of which bears a flagellum. Natatory setae absent. Three pairs of legs which are very alike but vary in size. Furca rudimentary, represented by two rounded lobes bearing one or more setae.

This family comprises few freshwater forms. None have hitherto been recorded from Australia.

Genus LIMNICYTHERE Brady, 1868

Shell usually thin, tuberculate or spiny. Antennules five-segmented, antennae four-segmented. Branchial plate of the mandible strongly developed. Furca very rudimentary.

Ten species have been described, a new one is here added from New South Wales.

LIMNICYTHERE ASPERA, n. sp. (Plate XXIX, figs. 4-8)

Female (fig. 4). Seen laterally, somewhat rectangular in shape, higher anteriorly than posteriorly, the greatest height occurring in front of the middle about the region of the eye. Dorsal margin straight for the greater part of its length, sloping down towards the posterior end and anteriorly forming an arch over the eye, ventral margin sinuated in front of the middle; anterior margin almost straight, curving slightly to meet the dorsal and ventral margins, posterior margin curved. Valves almost equal, each marked by a distinct lateral furrow. Surface not marked by any definite sculpturing but decidedly rough. Antennule (fig. 6) five-segmented, the terminal segment bearing three setae of

equal length and a fourth longer seta. Antenna (fig. 7) composed of four segments, flagellum long, unsegmented. Caudal ram (fig. 8) reduced to two rounded prominences, each bearing a terminal spine and a very short lateral spine. Colour brown. Length, 41 mm, height, 22 mm.

Distribution - N S W Byron Bay

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EXPLANATION OF PLATES XXIV-XXIX

Plate xxiv

Neunhamia fenestrata

Fig 1—♀ Lateral view (x 60), Fig 2—dorsal view (x 60), Fig 3—surface markings (x 225) Fig 4—shell margin (x 225) Fig 5—ventral plate (x 60), Fig 6—end segment, second leg (x 225), Fig 7—furca (x 358), Fig 8—end of antenna (x 225) Fig 9—second maxilla (x 550), Fig 10—second maxilla ♂ (x 550)

Plate xxv

Cypridopsis australis, ♀

Fig 1 Lateral view (x 88), Fig 2—dorsal view (x 88) Fig 3—surface (x 200), Fig 4—antenna (x 408) Fig 5—first leg (x 550), Fig 6—second leg (x 550) Fig 7—furca (x 350)

Plate xxvi

Cypris crinita *

Fig 1 ♀ Lateral view (x 25) Fig 2—♂ lateral view (x 25), Fig 3—♀ dorsal view (x 25), Fig 4—♀ antennule (x 62), Fig 5—♀ antenna (x 62), Fig 6—♀ first leg (x 70), Fig 7—♀ second leg (x 70), Fig 8—♀ furca (x 50)

Plate xxvii

Cyprinotus tenuis, ♀

Fig 1 Lateral view (x 67), Fig 2—dorsal view (x 67) Fig 3—surface (x 270) Fig 4—antenna (x 166), Fig 5—antennule (x 166), Fig 6—first leg (x 166) Fig 7—second leg (x 166), Fig 8—furca (x 170)

Plate xxviii

Figs. 1-5 *Cypretta hirsuta*, ♀

Fig 1—Lateral view (x 105), Fig 2—dorsal view (x 105), Fig 3—valve margin (x 210) Fig 4—end segment, second leg (x 525), Fig 5—furca (x 525)

Figs 6-7 *Herpetocypris laevissima*, ♀

Fig 6 Lateral view (x 72), Fig 7—furca (x 100)

Plate xxix

Figs 1-3 *Cyclocypris tenuissima*

Fig 1—♂ Lateral view (x 94), Fig 2—♀ lateral view (x 94), Fig 3—♀ furca (x 468)

Figs. 4-8 *Limnocythere aspera*, ♀

Fig 4—Lateral view (x 94) Fig 5—first leg (x 450) Fig 6—antennule (x 450), Fig 7—antenna (x 450) Fig 8—furca (x 450)

ANATOMICAL FEATURES OF THE MATURE SPOROPHYTE OF *SELAGINELLA ULIGINOSA*

By JESSIE K. STEEL, B.Sc.

(With nineteen Text-figures)

(Communicated by Professor A. A. Lawson)

[Read 25th July, 1923.]

Introduction

A classification of vascular plants, based on their reproductive and anatomical features, has been made by Professor Jeffrey (1897). According to this classification, vascular plants may be divided into two large groups. The first group, the Lycopsidea, includes the lycopods and their allies, and is characterised by plants bearing small leaves and ventral or adaxial sporangia. The vascular cylinder may be either siphonostelic or polystelic, but is distinguished by the fact that no foliar gaps occur. On the other hand, in the second group, the Pteropsida, the plants have relatively large leaves, and foliar gaps are a very characteristic feature of the vascular structure. The sporangia in these types are abaxial in position and, unlike those of the Lycopsidea, are numerous. In the higher members of the group true seeds are developed. The Pteropsida include the ferns, and the higher vascular plants, namely the Gymnosperms and Angiosperms.

Dr. Scott, however, is of the opinion that this classification should be slightly altered. He claims that the Lycopsidea should comprise the Lycopodiales only, while their allies, such as the Equisetales, Sphenophyllales and Psilotales, should be placed in a separate group, to which he gives the name Sphenopsida. The affinities existing among the members of this last group and the Lycopods are not, in Scott's opinion, sufficient to enable them to be classified together. The term Pteropsida is still retained by Dr. Scott to include the Filicales, Gymnosperms and Angiosperms.

Of the more important of the earlier investigations made on the anatomy of the mature sporophyte of *Selaginella*, mention may be made of the work of Spring (1840) who draws attention to the difference in anatomy in the creeping and erect stem. Later we come to the work of De Bary, who described the vascular bundle as being of the true fern type. Subsequent writers, as, for example, Vladescu (1889), were occupied with an investigation of the nature of the layers immediately surrounding the vascular cylinder—the endodermis and pericycle.

Towards the close of the nineteenth century, we have contributions to our

knowledge of the genus made by Strassburger and Van Tieghem. It is, however, to Professor R. J. Harvey Gibson that we owe most of our knowledge of the anatomical features of *Selaginella* as a whole. In a series of articles (1894-1902) he has given us a very exhaustive account of the anatomy of the stem, leaf ligule and root of a great number of species. Harvey Gibson's work was further carried on by Miss Mitchell (1910), who undertook an investigation of the structure of the strobilus. The nature of the root and the rhizophore, which is present in some species, has also been studied by Uphof (1920).

It is with a view to advance our understanding of the local species of *Selaginella*, that the following investigations have been made. These have been carried out entirely on the mature sporophyte, no attention being paid to cytological details in connection with the gametophytes or young embryos.

The Plant

Selaginella ulginosa is common to Eastern Australia, and grows prolifically both in very moist and in dry soil. The greater part of the material for this study was collected on the cliffs at Coogee, near Sydney, New South Wales, where it was growing under extremely moist conditions. Other material, however, both from the National Park and from the Blue Mountains, New South Wales, was growing equally well in exactly reverse conditions.

This species of *Selaginella* presents an interesting periodicity in the development of its vegetative organs. The aerial parts of the plant die away, generally after a period of reproductive activity, and fresh shoots arise from the underground rhizome, enabling the plant to carry on its activities for a prolonged season.

External Morphology

In its external morphology, this species of *Selaginella* somewhat resembles *S. laevigata* as described by Harvey Gibson, but the internal anatomy of the two forms shows many distinguishing features. *S. ulginosa* is characterised by a very distinct rhizome (Text-fig. 1) which may sometimes branch, and which varies from about 2 to 4 cm. in diameter. The rhizome bears erect aerial shoots, with leaf bases in the lower portions. These shoots are found in close proximity to the point at which the root is given off, a feature characteristic of the Lycopsidea in general. They are about 1 cm. in diameter in their thickest part, and grow to a height of 10 to 12 cm., although some were found of much greater length. The shoots bear two rows of lateral branches, bearing the leaves which are very small, acute, sessile and decussate.

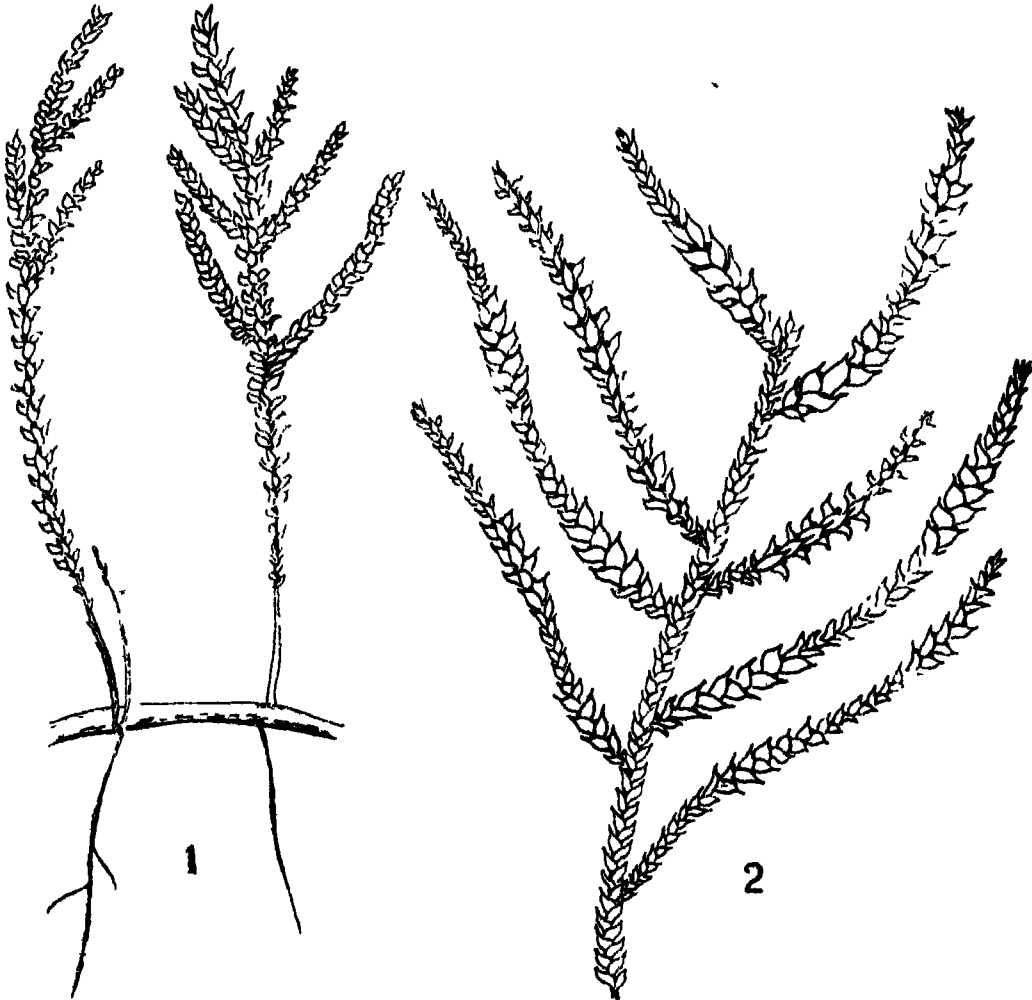
The reproductive organs are found in square shaped cones, either terminating the main axis or the lateral branches. Numerous specimens, however, were found in which vegetative growth had continued from the axis of the cone, after the completion of its reproductive activity (Text-fig. 2). Attention has already been drawn to this fact by Osborn (1915). The occurrence of alternating sterile and fertile regions is suggestive of the conditions found in the more primitive Lycopodiales. This, together with other facts relating to the distribution of the sporangia, to be described later, would tend to place *S. ulginosa* among the lower species of the genus, since it shows close affinities to such types as *Lycopodium selago*.

S. ulginosa is characterised by the absence of the so-called rhizophores, a point in which it resembles *S. cuspidata* and *S. laevigata*. The roots which, as

already mentioned arise in close proximity to the aerial shoots, average .5 to 1 mm in diameter, and may give off lateral roots of much smaller dimensions.

Anatomy

In describing the microscopical anatomy of this type, the writer has, for convenience, adopted the nomenclature for the various tissues given by Harvey Gibson in his work on the anatomy of the genus. These terms, as he points out,

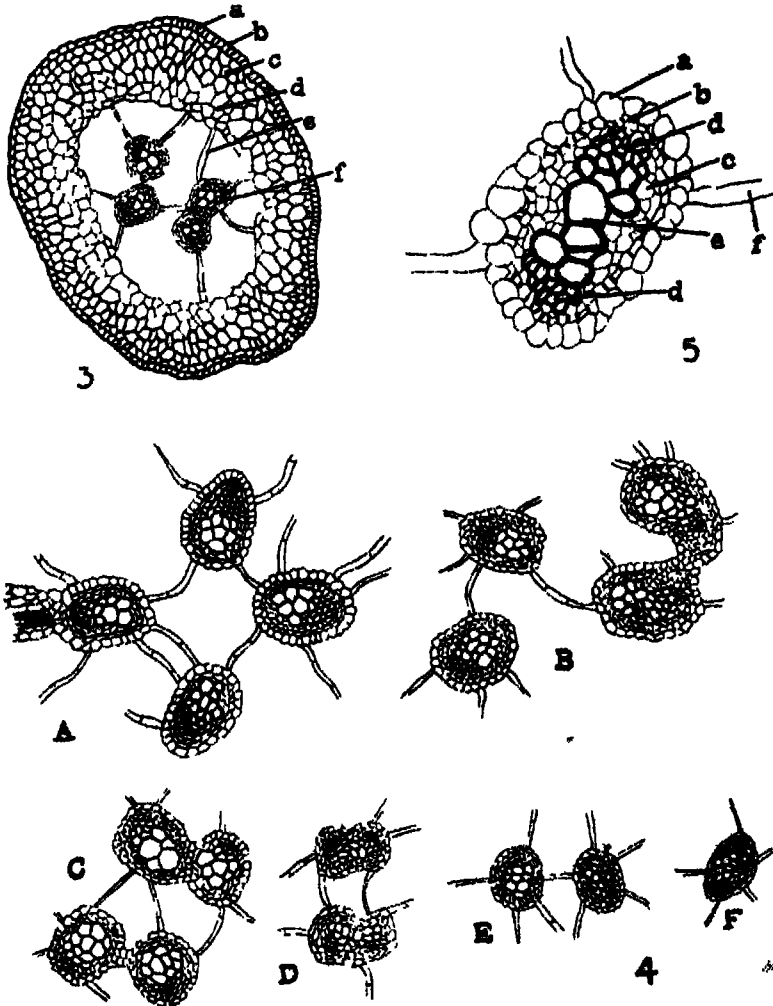


Text-fig 1.—Habit Study of *S. uliginosa*

Text-fig 2.—Aerial shoot of *S. uliginosa* showing alternating reproductive and sterile regions.

are used purely "in a descriptive sense." The limiting layer of the stem, he has called the "epidermis," while the sclerised layer, usually lying inside this, is known

as the "hypodermis" This gradually merges into the ordinary parenchymatous cells of the "cortex" The unicellular or multicellular strands uniting the vascular cords to the cortex are termed "trabeculae", these may be composed of either an



Text-fig 3 — T S Aerial stem *S. uliginosa* a, epidermis, b, cuticle, c, hypodermis, d, cortex, e, trabeculae, f, steles (x 40)

Text-fig 4 — T S Steles taken at different levels in the aerial stem of *S. uliginosa*. (x 40)

Text-fig 5 — T S Single stele *S. uliginosa* a, endodermis, b, pericycle; c, phloem, d, protoxylem, e, primary xylem, f, trabeculae. (x 320)

endodermal cell or two or more parenchymatous cells, connected with the endodermal cell to form a trabecula. The "endodermis" is composed of anticlinal cells arising from the chlorophyllaceous layer surrounding the stele. This layer

Harvey Gibson has called the "pericycle." The term "vascular bundle" is used to indicate a leaf-trace only, while the "stele," refers to the vascular strand, enclosed within the so-called endodermis and pericycle.

The Aerial Stem

In transverse section, the aerial stem of *S. uliginosa* (Text-fig. 3) is seen to have a distinct epidermis, with a very well marked cuticle. In sections towards the base of the shoot, there is a well defined hypodermis of sclerenchymatous cells gradually merging into the thin-walled cells of the cortex. This hypodermis is not so well marked in sections near the apex. The centre of the section is occupied by a large lacuna, traversed by unicellular or multicellular trabeculae which serve to connect the stele or steles, as the case may be, to the cortex.

Sections were cut at various positions in the aerial stem, and up to as many as four steles were found (Text-fig. 4). In some of the younger shoots examined, however, this division into four had not taken place. As the apex of the shoot is reached, the four steles gradually become joined, until finally only one remains.

On closer examination of the stele, it was seen to have a well-defined endodermis (Text-fig. 5) of relatively large cells, with a pericycle, the radial walls of each cell of which appeared thickened. The phloem is composed of protophloem and phloem parenchyma. It completely surrounds the xylem, but is poorly developed in the region of the protoxylem. In sections showing four steles, the protoxylem of each stele lies to the outside of the primary xylem. As the steles join up, this position is retained, until finally, when one stele remains, it is seen to have a group of protoxylem at either side. The tracheids of the xylem show well-marked spiral and scalariform thickening. It must be noted in connection with the vascular structure of the aerial stem, that at the point where the vascular bundle goes to the leaves, no gap occurs. This is one of the chief characteristics which place the Selaginellas among the Lycopoda.

The Leaf

The leaf, in transverse sections (Text-fig. 6), showed a thick cuticle developed on both upper and lower surfaces. The epidermal cells are fairly regular in shape; stomata each possessing two guard-cells occur on the lower surface of the leaf (Text-fig. 7) and are developed in the region of the midrib.

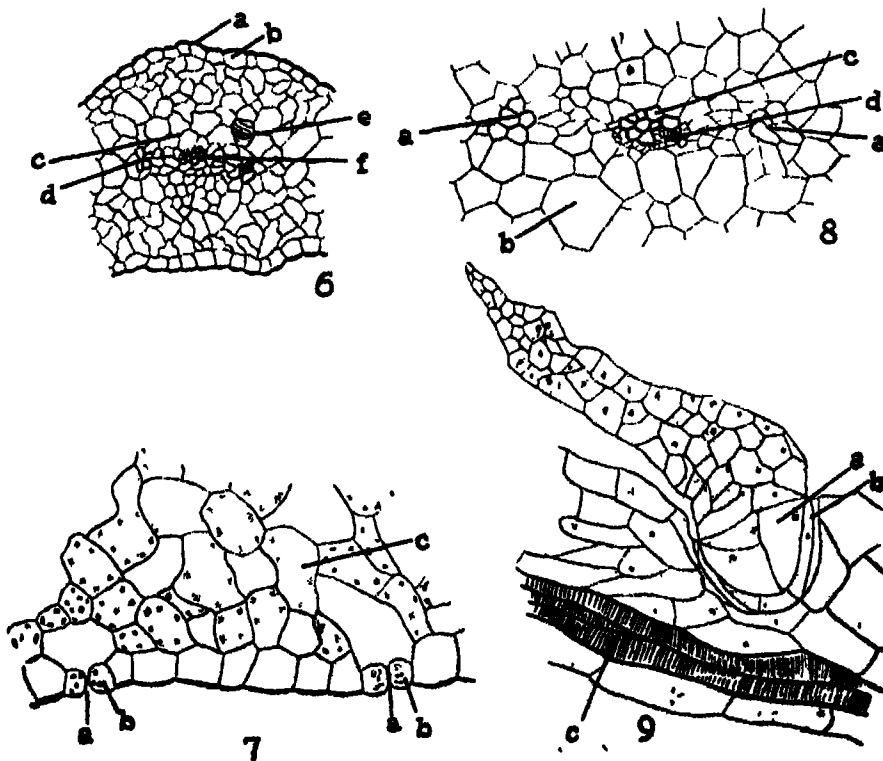
There is no development of palisade tissue in the leaf of *S. uliginosa*, the bulk of the leaf being composed of a very loose network of mesophyll cells (Text-fig. 7) containing chlorophyll and with abundant air spaces between. In the region of the midrib, the cells are very much enlarged and rather mucilaginous, possibly serving to retain water. Two groups of somewhat thick-walled cells occur on either side of the vascular bundle (Text-fig. 8). These are young tracheidal cells and in some a definite thickening could be seen on the walls. No definite endodermis and pericycle were observed in the leaf, except perhaps at the extreme base, where the vascular bundle first arises from the stele of the aerial stem. The vascular bundle is composed of xylem and phloem, the former lying to the upper side of the leaf, and composed of the characteristic scalariform tracheids.

The Ligule

In close association with the leaves of *S. uliginosa* is found the ligule. It

occurs in the axil between the upper surface of the leaf and the aerial shoot. For the most part, the ligules occurring with the sporophylls of the cone seemed much better developed, several good examples were found, however, in association with the leaves. In longitudinal section (Text-fig 9) the vascular bundle running out from the central stele to the leaf, was seen to be in close proximity to the base of the ligule.

As has been described by Harvey Gibson, the ligule is composed of a mass



Text-fig 6 — T S Leaf *S uliginosa* a, cuticle, b, epidermis, c, mucilaginous cells, d, group of thick-walled cells, e, young tracheidal cell; f, vascular bundle (x 150)

Text-fig 7 — T S Lower epidermis of leaf of *S uliginosa* a, stomata, b, guard-cells, c, mesophyll (x 310)

Text-fig 8 — T S Vascular bundle of leaf of *S uliginosa* a, young tracheidal cells, b, mucilaginous cells, c, xylem; d, phloem (x 310)

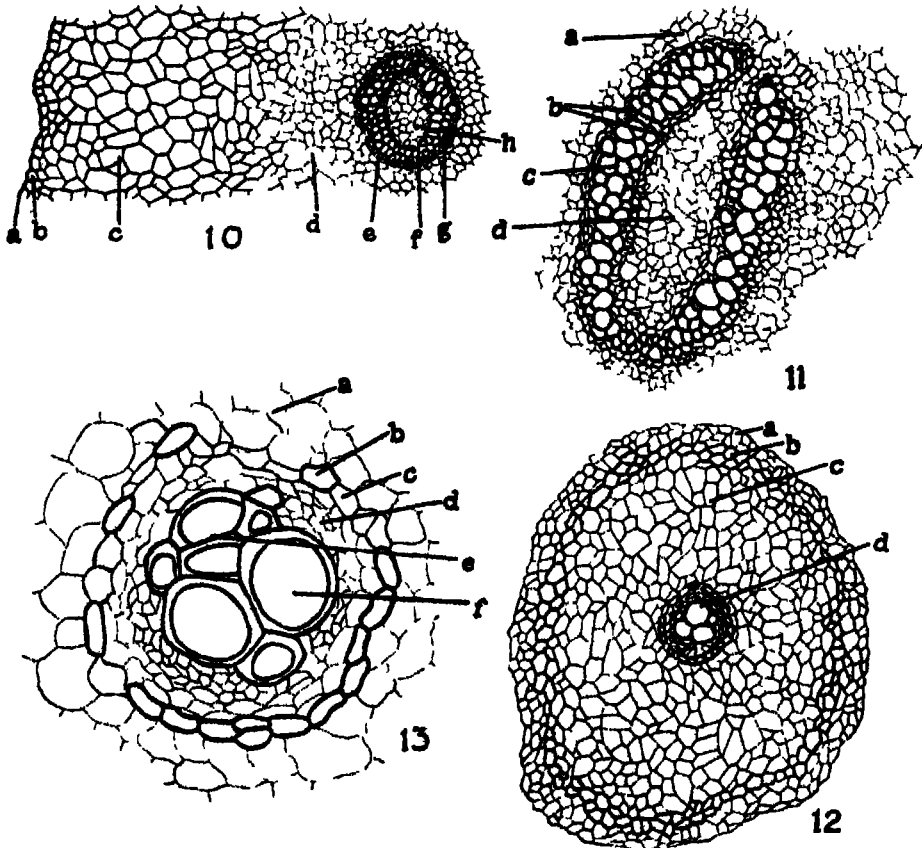
Text-fig 9 — L S Ligule *S uliginosa* a, glossopodium, b, sheath, c, vascular bundle running to leaf. (x 310)

of cells with rather dense protoplasmic contents. It is swollen at the base, forming the glossopodium, composed of very large thin-walled cells, and surrounded by a sheath of narrow cells. In *S uliginosa* the ligule tapers very much towards the apex, the cells possessing dense granular contents and very distinct nuclei.

The Rhizome

As has been previously mentioned, the rhizome forms a very characteristic feature of *S uliginosa*. In transverse section (Text-fig 10) the epidermis shows a thick cuticle, its cells being square in shape. Within the epidermis we find a relatively wide cortex, composed towards the outside of a hypodermis of sclerised cells which gradually merge into the smaller and thin-walled cells of the inner cortex.

The rhizome of *S uliginosa* is solenostele in its vascular structure, but the



Text-fig 10.—T. S. Rhizome *S uliginosa*. a, cuticle; b, epidermis, c, hypodermis, d, cortex, e, phloem, f, protoxylem; g, primary xylem, h, pith. (x 125)

Text-fig 11.—T. S. vascular cylinder of rhizome of *S uliginosa*, showing branch gap. a, cortex, b, phloem, c, xylem; d, pith. (x 70)

Text-fig 12.—T. S. root *S uliginosa*. a, epidermal cells, b, hypodermis; c, cortex; d, stele (x 70)

Text-fig 13.—T. S. Stele of root of *S uliginosa*. a, cortex, b, thick-walled endodermal cell, c, thin-walled endodermal cell, d, phloem, e, protoxylem; f, primary xylem (x 310)

endodermis and pericycle are not quite as definite as in the aerial stem. The greater part of the vascular cylinder is made up of the scalariform tracheids of the xylem, with internal and external phloem. The centre of the section is occupied by the thin-walled cells of the pith.

The solenostelic character of the rhizome of *S. uliginosa* is of particular interest phylogenetically. This point is emphasized by Tansley, who says "The solenostelic or siphonostelic vascular cylinder seems an intermediate step between the primitive protostelic types on the one hand and the more highly advanced dialystelic types on the other." Bower also refers to the occurrence of this condition, in describing the anatomy of the axis of *Selaginella*, in the following words "In the more complex cases, the axis becomes polystelic or in some cases solenostelic (rhizome of *S. laevigata*) thus resembling similar vascular complications seen in the stems of Ferns. These may be held to be relatively late, and special developments from the non-medullated, monostelic type, their origin shows parallelism of development rather than any nearer relation with the similar structure seen in the Ferns."

At the point in the rhizome from which a branch is given off, a distinct gap occurs in the vascular cylinder. A transverse section made at this point (Text-fig 11) shows the phloem continuous round the end of the xylem, uniting with that of the inner side. At the gap, the parenchymatous cells of the cortex come in direct contact with those of the pith. It is important to note that in this case, although the gap is prolonged forward, still no overlapping takes place, a step which would lead to a dictyostelic condition. The occurrence of the gap, however, has an interesting bearing on the relationship of this type with higher forms.

The Root

The root exhibits several characteristic features. In the first place, the epidermis is not so clearly differentiated from the underlying cells as in the other organs examined, and the cuticle, although present, does not show the extensive thickness met with in other sections (Text-fig 12). In several sections of the root, there appear several rows of parenchymatous cells within the epidermis, while in others it gives place directly to a thick-walled hypodermis, an outstanding feature of the root section. Within this hypodermis lies a relatively wide cortex of parenchyma enclosing a single stele.

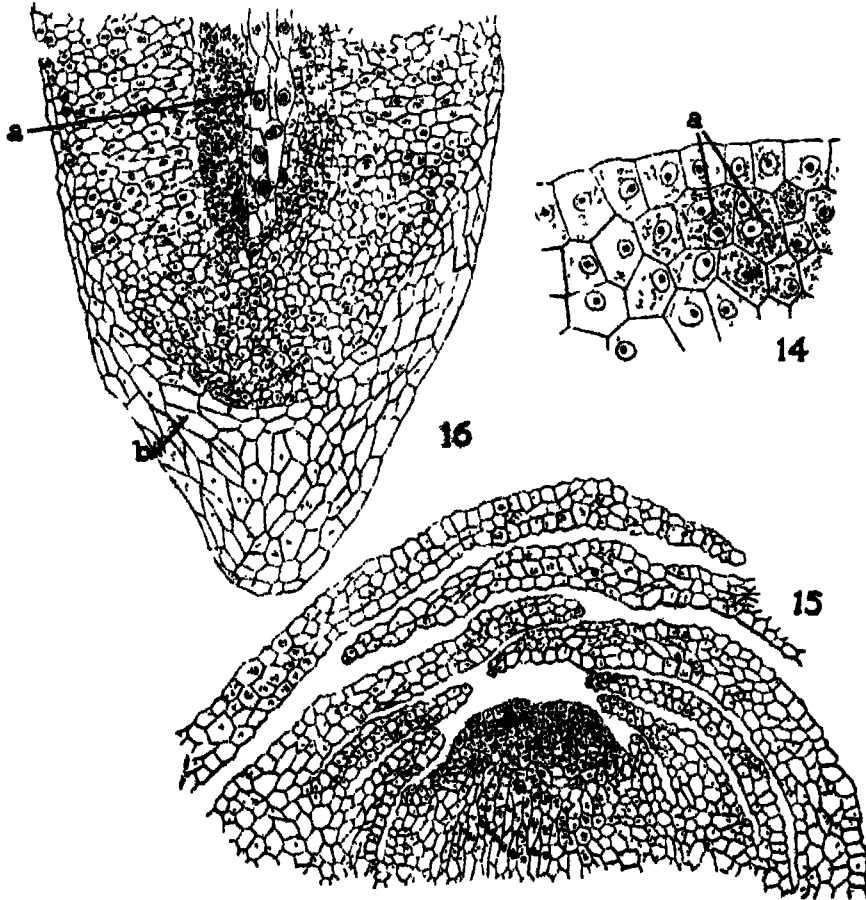
Unlike the rhizome, the root possesses a well defined endodermis and pericycle. The endodermis is usually one layer in thickness (Text-fig 13) and is composed, for the most part, of sclerified cells. In the places where this thickening has not taken place, the endodermal cells can still be traced. The pericycle is composed of parenchymatous cells, within which lie the elements of the phloem. In the root, the primary xylem is usually made up of three or four very large tracheids, there being a single group of protoxylem elements at one side. The phloem is poorly developed in this region.

The Apexes of the Rhizome and Root

The growing region of *S. uliginosa* has some interesting points. Growth could not be traced to a single apical cell, but rather to a group of cells lying just below the dermatogen and possessing very dense cytoplasmic contents. Very many sections of the apex of the rhizome were made, but in none was there evidence of a single apical cell, as in many other Pteridophytes. Instead, the dermatogen was continuous over the apex, while lying beneath it was a small group

of cells (Text-fig. 14), one or two of which appeared to possess two nuclei, as if the cells were in the act of division. Other cells, adjacent to these, seemed to have recently divided, although no trace of any spindle could be seen. It therefore seems highly probable that growth in *S. uliginosa* takes place from a group of meristematic cells and not from a single apical cell.

Attention has been drawn to the phylogenetic significance of this interesting point by Bower (1889) thus: "In many species of *Selaginella* a single initial cell



Text-fig. 14.—L. R. Apex of rhizome of *S. uliginosa* a, meristematic cells (x 710)

Text-fig. 15.—L. S. Apex of rhizome of *S. uliginosa* showing enveloping leaves (x 175)

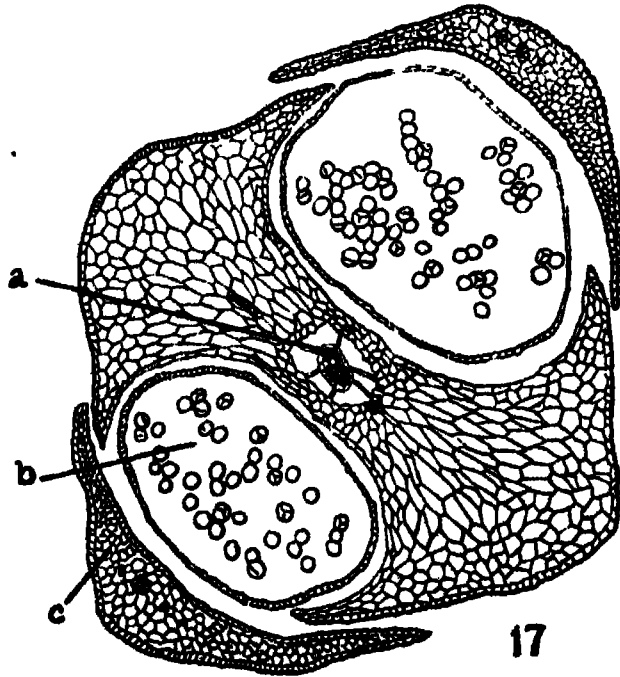
Text-fig. 16.—L. S. Apex of root of *S. uliginosa* a, young tracheidal cells; b, root-cap (x 175)

is formed in the subaerial stem, in other species there is a more complex structure of the meristem, while in *Lycopodium* three initials have been observed, though the general habit is similar to that of the allied *Selaginellas*." The complex structure of the meristem may therefore be regarded as a primitive feature, since

it is found in the genus *Lycopodium* and also in *S. spinulosa*, a type which on the grounds of its radial shoot and anatomical structure is regarded as essentially primitive

Another interesting feature of the apex is the very characteristic manner in which the young leaves envelope it, as shown in Text-fig 15

In regard to the apex of the root, the dense cytoplasmic nature of the cells was again noted. There is a distinct root-cap of large, loose, thin-walled cells. Some distance back from the apex, the differentiation into dermatogen, periblem and pleurone could be seen (Text-fig 16). Several very large nuclei were found in the centre of the section, occurring in elongated cells which would later develop into the tracheids of the older root. As in the apex of the rhizome, no definite



Text-fig 17 —T S Cone of *S. uliginosa* a, stele, b, sporangia, c, sporophyll.
(x 160)

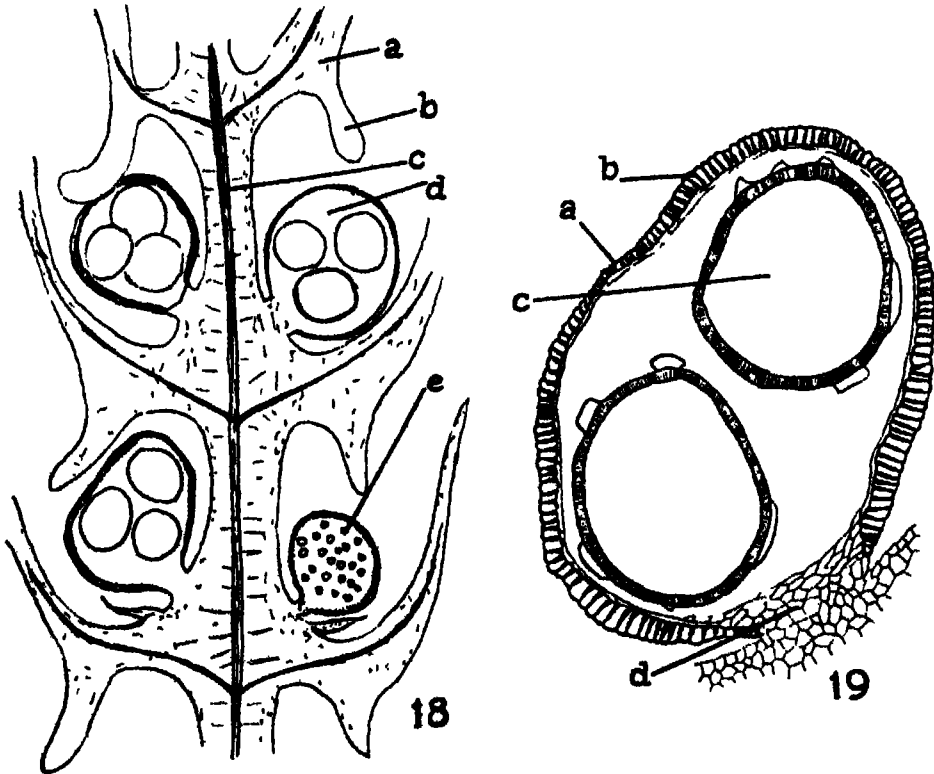
apical cell was observed, so that it is probable that in the root, we have a meristem similar to that described above for the rhizome apex

Spore Production

As already stated, the cones of *S. uliginosa* either occur at the apex of the lateral branches or terminate the main axis. In transverse section they appear almost square (Text-fig 17), the anatomical details closely agreeing with those of the aerial stem. The cuticle of the epidermis is again a feature of note, but is not so well developed on the epidermis bordering the sporangia. The sporophylls are arranged in four sets around the central axis, the vascular structure of this axis recalling that of the vegetative shoot. In the centre is a large lacuna,

traversed by unicellular or multicellular trabeculae which hold the single stele of the axis in position. The endodermis and pericycle are again clearly differentiated, the phloem surrounds the main mass of xylem which possesses two groups of protoxylem. The sporophyll bundles join the axial strand in the region of the protoxylem, the endodermis being continuous for a very short distance at the base of the sporophyll. Oblique sections of these bundles are often found in the cortex of the central axis. They are essentially similar in their vascular anatomy to the ordinary vegetative leaves.

In longitudinal section (Text-fig 18) some further interesting anatomical features are to be noted. The single central stele of the axis is very conspicuous,



Text-fig 18.—Sketch of L. S. Cone of *S. uliginosa*. a, sporophyll, b, flap, c, stele of axis, d, megasporangium, e, microsporangium.

Text-fig. 19.—L. S. Megasporangium of *S. uliginosa*. a, line of dehiscence, b, wall; c, megaspore, d, stalk (x 160).

and from this vascular bundles are given off to the sporophylls. The latter are prolonged into a distinct flap on the lower side, and bear sporangia on the upper. The occurrence of this well developed dorsal flap protecting the sporangia in many species of *Selaginella* is regarded by Sykes and Styles as a primitive feature, recalling the condition found in such types as *Lepidostrobus* and *Spencerites*. The sporangia of *S. uliginosa* are borne in the axils of the sporophylls, so that they

arise from stem tissue and not from leaf tissue as in the more primitive members of the Lycopodiales.

Lying between the sporangia and the sporophyll is the ligule. This shows the same anatomical features as have been previously described for this organ as it occurs with the vegetative leaf, but it is more perfectly developed. The vascular bundle of the sporophyll is in close proximity to the base of the ligule, but no bundle is developed to the sporangium.

As regards the distribution of the microsporangia and megasporangia, *S. uliginosa* shows some interesting features. On examining the very young cones, the writer found that only microsporangia were present, but later, however, megasporangia make their appearance. Numerous examples were found in which the megasporangia were borne towards the centre of the cone, while microsporangia were lying both above and below.

A similar arrangement to this has been noted by Sykes and Styles in *S. pumila* and Miss Mitchell also finds this indiscriminate arrangement in such types, as *S. Martensii*, *S. caulescens*, *S. patula*, *S. cuspidata* and others. Phylogenetically, this feature is of great importance, and must be regarded as distinctly primitive, the more advanced types being those in which the microsporangia are borne towards the apex while the megasporangia lie at the base of the cone, giving a possibility of pollination by gravity.

In a few cases of the cones of *S. uliginosa* examined, an abortive sporangium occurred at the apex of the cone, being a possible indication that a second vegetative phase was being entered upon. No cones were found showing megasporangia only.

In structure, both sporangia show a very much thickened wall. The microsporangia all contain numerous microspores, with a distinct tetrahedral division and a relatively smooth wall. On the other hand, the megasporangia (Text-fig 19) in all cases examined, were found to contain four large megaspores, giving a four-lobed appearance to the sporangium. Each megaspore possesses a thick spiny wall. As has been previously stated, no examination of the gametophytic cells was made, as the material had not been preserved with a view to the cytological examination of these features.

Summary

The chief facts to be gathered from the above investigation are as follows —

1. *S. uliginosa* is characterised by the presence of a radial type of shoot and a distinct rhizome. The aerial shoots and roots are given off from the rhizome in close proximity to one another.
2. The rhizome is solenostelic, with gaps at the point of departure of a branch.
3. The vascular structure of the aerial stem shows as many as four steles.
4. The leaves are small, decussate, and well adapted to xerophytic conditions because of their thick cuticle, relatively few stomata, and the occurrence of mucilaginous and tracheidal cells in the region of the vascular bundles.
5. The root is protostelic, there is only one group of protoxylem.
6. Growth, both in rhizome and root, probably takes place from a group of meristematic cells lying below the dermatogen, rather than from a single apical cell.
7. The cones are borne at the apices of the main branch or terminating the lateral shoots. A "selago" condition is common.

- 8 Microsporangia and megasporangia show an indiscriminate arrangement, the latter, when present, generally occupying the centre of the cone
 9. The microspores are numerous, but there are only four large megaspores.

The above facts lead us to conclude that *Selaginella uliginosa* may be classed among the more primitive species of the genus. In relation to its external morphology, we may quote the words of Bower, "The discussion of the external morphology of the genus *Selaginella* has led to the recognition of the radial type as relatively primitive, while those species with dorsiventral shoots are held to be more specialised and derivative." This, together with the frequent occurrence of a *Selago* condition, the mixed arrangement of the sporangia in the cones, and the presence of four megaspores within the megasporangium, all points to a close relationship with the more primitive members of the Lycopodiales. On the other hand, in the anatomy of the rhizome, there appears to be a slight advance on the primitive condition. It must be remembered, however, that the gaps formed in the solenostele are caused by the departure of a branch, and not by a leaf trace as in the more advanced Pteridophytes.

A study of such primitive types as *S. uliginosa* must lead to a clearer knowledge of the importance of the genus among other vascular plants. Its heterosporous character, combined with its relatively simple vegetative anatomy, makes *Selaginella* one of the most interesting types, and one deserving very detailed examination.

In conclusion, the writer wishes to express her indebtedness to Professor A. A. Lawson and Dr J. McLuckie for the advice and help they have given her in the more difficult problems connected with this study.

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STUDIES ON AUSTRALIAN MOLLUSCA. PART XIV

By C HEDLEY, FLS

(Plates xxx-xxxiii., and one Text-figure.)

(Continued from Vol xli., p. 719)

[Read 25th July, 1923]

ARCA OBTUSOIDES Nyst

Arca obtusoides, Nyst, Tabl syn Arcacées Mém Acad Roy Belgique, xxii, 1847, p 50 for *Arca obtusa* Reeve, Conch Icon, ii., 1844, Pl xii, fig 77, not *Cucullaea obtusa* Phillips, 1836—*Arca obliquata*, Reeve, not Gray, *op cit*, fig 80—*Arca sinensis*, Philippi, Zeitsch f Malak, viii, 1851, p 53—*Barbatia decurvata*, Dunker, Index Moll. Mar Jap, 1882, p. 232; Lamy, Journ de Conch., iv, 1907, p 73

Specimens from Moreton Bay were identified by Mr E A. Smith in 1889 as *A sinensis* I gathered a series at the mouth of the Annam River in August, 1916

BERTHELMIA

Berthelma, Crosse, Journ de Conch, xxiii, 1875, p 39, Pl ii, fig 3, Morch, Journ de Conch, xxiv, p 374, Crosse and Fischer, Journ de Conch, xxxv, 1887, p 305, Pl x, Fischer, Man Conch., 1886, p 950, Cossmann, Ann Soc Roy Malac Belg xxii, 1887, p 170, Pl vii, figs 24-29, Pl viii., figs 1-2

Referring to an article on *Edentellina* (Hedley, Proc Malac Soc, xiv, 1920, pp 74-76), Mr M Cossmann wrote to me, "En effet vos figures d'*Edentellina* sont identiques à celle de *Berthelma* Crosse," the "identiques" is doubly underlined As I have not seen *Berthelma* I cannot express an opinion on this synonymy

This identification lends an unusual interest to the Australian species as indicating a remarkable longevity For *Berthelma* was based on a fossil from the Eocene of the Paris basin This eccentric type was first regarded as related to *Capulus*, then Morch transferred it to the Pleurobranchidae and Fischer finally assigned it to the true position in the Julidae

PEDUM SPONDYLOIDEUM Gmelin

Ostrea spondyloidea, Gmelin, Syst Nat, xiii, 1791, p. 3335, not *Ostrea spondyloides*, Gmelin, *op cit.*, p. 3321—*Ostrea pedum*, Bolten, Mus Bolt. 1798, p. 170.—*Pedum spondyloideum*, Reeve, Conch Icon, xi., 1858, Pl i, fig 1, Chenu, Illustr Conch, 1848, Pedum p. 1

A genus is added to the Australian fauna by a single notched valve of this species, which I gathered on the beach of Lizard Island, 19/7/16

SPONDYLUS ANACANTHUS Mawe

Spondylus anacanthus, Mawe, Linn Syst Conch, 1823, p. 47, Pl xi., fig. 3; Fulton, Journ of Conch, xiv, 1915, p 359

This distinct species is as yet unrecorded for Australia. On the beaches of Palm and of Lizard Islands I have gathered a few dis-associated valves.

LIMA STRANGEI Sowerby.

Lima strangeri, Sowerby, Conch leon, xviii, 1872, Pl iii, sp 15

In his recent monograph of the family Limidae in the Conchylien Cabinet, Dr J Thiele follows the Challenger Report in reducing *Lima strangeri* to a synonym of *L. bullata*. The original figure of *L. bullata* (Born, Mus Caes Vindobon, 1780, p 110, Pl vi., fig 8) shows a shell, ascribed to Barbadoes, broader and more inflated than our form. Dr F Brauer, who re-examined Born's type, confirmed (Sitz. k Akad Wiss, lxxvii, 1878, p 23) the specific identity of Sowerby's figure of a Philippine specimen of *L. bullata*, in the Conchologica leonicea 3a, 3b, with Born's type of *L. bullata*. Certainly there is a difference between *L. bullata* and *L. strangeri*.

It appears to me that *Lima jacksonensis* (Thiele, Conch Cab, vii, 1920, p 51, Pl 9, fig. 26, type locality, Port Jackson) is actually based on a young specimen of *L. strangeri* and thus an Australian species is simultaneously rejected as *strangeri* but restored as *jacksonensis*.

To *L. jacksonensis* Dr Thiele doubtfully referred the Tasmanian Tertiary fossil erroneously identified by Tenison Woods (Proc. Roy Soc. Tasm, 1876 (1877), p 113) as *L. subauriculata* Montagu. But Tate had already made the correction by naming (Proc. Roy Soc Tasm, 1884 (1885), p 230) that fossil *L. jeffreysiana*.

MODIOLUS AREOLATUS Gould

Mytilus (Modiola) areolatus, Gould, Proc Bost. Soc Nat. Hist., iii., 1850, p 343 and Moll Am Expl Exped, xi, 1852, p. 452, Pl 41, fig 562 — *Modiolus australis*, May, Illustr Index Tas Shells, 1923, Pl. iv., fig 7.

There is a large bearded mussel common to New Zealand and Tasmania and which reaches north to the latitude of Sydney. This has been generally accepted as *Modiola australis* Gray, a view of its identity expressed by Pritchard and Gathiff (Proc Roy Soc Viet, xvii, 1904, p 251) and by Suter (Man. N.Z. Moll, 1913, p 867). But writers have not been quite unanimous, for early in its literary history Menke proposed (Zeits Malak, i., 1844, p 63) to unite *M. australis* with *M. albicosta* Lamarek, a judgment that was probably correct. The few remarks Gray made about his single worn and unlocalised valve are a poor foundation for a species. In 1857 Reeve gave a figure of *M. australis* based on material brought from Queensland by Jukes and which may have belonged to a different species. This shows a high pitched dorsal margin and very prominent umbos, a contour, in short, quite unlike the southern form with which this name is usually associated.

It is now suggested that Reeve's figure of *M. australis* actually represents the shell named *Modiola plumescens* by Dunker and refigured by Lyngø and Odhner. But whether Gray's *M. australis* be *albicosta* or *plumescens* or neither, it is incompatible with the southern shell.

So it is proposed to advance for service in place of the misused *M. australis*, Gould's name of *M. areolatus* which is clearly identifiable from good figures and description, and of which New Zealand is the type locality.

HEMIDONAX DACTYLUS, n.sp (Plate xxxi, fig 13.)

Shell elongate ovate, somewhat the shape of a date stone, solid, a little compressed, anterior end three-fifths of total length, linguiform, posterior side short and broad with rounded angles. Colour pale buff suffused with pale lavender towards the beaks; on this ground are irregularly disposed, narrow, radiating, brown lines sometimes in broken lengths and sometimes in jagged forks; the interior has a white margin round a livid brown centre. Sculpture: irregular concentric growth lines, waved at the passage of the radials, overrun the whole shell, the centre of the disk is traversed by about eighteen rather coarse, evenly spaced, radial riblets, the anterior third and posterior sixth being left smooth, as striae these radials are noticeable on the umbonal area, independent of these radii is another series of closely packed microscopic hair lines which overrun the whole shell except a narrow anterior and posterior segment. On the inner ventral margin are twenty-two strong denticles, followed, after a few transitional buff teeth, by a series of sixteen smaller teeth at the anterior end, all these are visible from outside when the valves are clenched. The beaks make a close approach to one another. The ligament is wholly external, whereas in *H. pictus* it has made progress in descent into the hinge plate. Length, 27, height, 16, breadth of conjoined valves, 12 mm.

Hab—NS Wales: Kiama (type, R Helms), Twofold Bay (self), Gerrin-gong (Mr. Varney Parkes), Sydney (Miss L Parkes), Port Stephens (Hargraves Coll.)

This species is readily distinguished from *H. pictus* which inhabits the same zoological subregion, by its slender form and rounded posterior margin. It is indeed the narrowest of the genus.

Dr Lamy has given a valuable summary of the genus *Hemidonax* (Journ. de Conch., lxi, 1917, p. 264) with complete bibliography and figures of the hinge of *H. cardoides*. Though some previous writers have counted two or three species Dr Lamy regarded *Hemidonax* as a monotypic genus. On the contrary I point to four distinct Australian species in addition to the novelty described above.

To begin with, *Hemidonax donaciformis* should be rejected from the Australian fauna because the original figure (Schroeter, Einleit. Conch., ii, 1786, p. 68, u. Pl. vii, fig. 14) shows a subtriangular shell, inequilateral, with a very short posterior side, grooved across the whole breadth of the valve, this is quite unlike any of the shells figured under the name of *donaciforme* by Wood, Sowerby, Reeve, Chenu or Romer.

The first Australian species was named *Donax cardoides* by Lamarck (An. s. vert. v, 1818, p. 550). It is an equilateral shell, furrowed across the whole breadth of the disk and with an orange spot inside, its type locality is the Nuyts Archipelago in the Great Australian Bight. Later, it was figured by Delessert (Recueil, 1841, Pl. vi, fig. 14). From Papuan material it was figured by Quoy and Gaimard (Zool. Astrolabe, iii, 1835, Pl. 81, fig. 17-18) and again by Hanley (Cat. Recent Shells, 1843, p. 82, Pl. 13, fig. 9). Probably this is the species which Reeve (Conch. Icon., ii, 1844, Pl. 5, fig. 25) and Romer (Conch. Cab., 1869, p. 109, Pl. 14, fig. 16, 17) misidentified as *Cardium donaciforme*. But the *Hemidonax* common in South Australia and Victoria reported as *cardoides* by Tate (Trans. Roy. Soc. S.A., ix, 1887, p. 86) and by Pritchard and Gathff (Proc. Roy. Soc. Victoria, xvi, 1903, p. 119) appears to me to be a second

distinct species and has been described by Gathiff and Gabriel as *H. chapmani* (Viet Nat, xi, 1923, p 10, Pl n)

The third Australian species is the *Cardium austrahense* of Reeve (Conch. Icon, ii, 1844, Pl v, fig 24) This is also equilateral but is differentiated from the previous species by being smooth on the anterior half Brazier wrote (These Proceedings, v, 1880, p 487) that it is rare in South Australia. Perhaps it has not been taken there since Dr J B Harvey obtained the type at Port Lincoln about 1842 It seems to me to be the species figured as *Cardium donaciforme* by Sowerby (Conch Illustr Cardium, 1840, p 6, Pl vi., fig 27) Under the name of *Donacardium austrahense* it was refigured by Vest (Jahrb deut mal gesell, iii., 1876, p 291, Pl 10, fig 1).

A third Australian species was published by Tryon (Am Journ Conch, vi, 1870, p 23, Pl 1, fig 1) as *Donax (Serrula) pictus* The habitat was unknown to that writer; specimens before me show *pictus* to range from Sydney north to Port Curtis, Queensland Lake *austrahense* it has a smooth anterior end but is less equilateral than that and when full grown develops a posterior heel, it is very solid and one of the largest of the genus, reaching a length of 40 mm

Dr W H Dall (Trans Wagner Inst, iii, 1900, p 963) has named *Cardium donaciforme* Spengler as the type of this genus But von Martens noted (Zool. Record, 1870, p 172) that according to Moreh the type of *Hemodonax* is *Donax pictus*

I repeat my conclusion (These Proceedings, xxx, 1906, p 540) that *Hemodonax* is nearly related to *Cyamusomactra*, this affinity is more apparent in the young stages of *Hemodonax*

Dr Lamy rejects my suggestion that *Hemodonax* might enter the Crassatellidae and restores it to Donacidae I feel more confident that the entire palial margin should exclude it from the Donacidae than it should provide admission to Crassatellidae It is not clear why Dr Lamy disallowed Fischer's reference to Tancredudae.

CARDIUM OXYGONUM Sowerby

Cardium oxgonum, Sowerby, Conch Illustr Cardium, part 47, fig 9, 1833, Sowerby, Proc Zool Soc, 1840, p 107, Reeve, Conch Icon, ii, 1845, Pl 16, fig 77, Tryon, Am Journ Conch, vii, 1872, p 262, Shirley, Proc Roy Soc. Queensland, xxiii, 1911, p 95

Little is recorded of the distribution of this species The following may be noted—Queensland: Burnett River (Shirley), Caloundra (T. H. Johnston), N S Wales: Trial Bay (C Laserson), Middle Harbour (Miss L Parkes)

OPISOCARDIUM GUICHARDI Bernardi

Cardium guichardi, Bernardi, Journ de Conch, vi, 1857, p 53, Pl. 2, fig 4.

Unrecorded for Australia. I collected several separate valves on a beach at the mouth of the Annam River, North Queensland

PITARIA INCONSTANS, n sp (Plate xxxi, fig 14, 15, 16)

Shell small, solid, much inflated, roundly subtriangular, posterior end twice as long as the anterior, variable in the extent to which the posterior end is abbreviated or prolonged Colour buff, fading to white at the margin and darkening to pale orange at the umbo, within pale yellow Sculpture: fine concentric hair lines imposed on irregularly spaced larger undulations. Umbo protuberant,

apex incurved Lunule limited by a faint impressed line Length, 14, height, 12, depth of single valve, 4 mm

Hab—Cairns, Queensland Abundant on the beach as dead shells (self)

Judging from the illustration, this is related to *Cytheraea acuminata* Sowerby (Thes Conch, ii, 1853, p 633, Pl. 136, fig 178) but differs by being longer in proportion to height and by the shorter anterior end

ANTIGONA LEVUKENSIS Smith

Venus (Chione) levukensis, Smith, Chall Report, Zool. xii, 1887, p 128, Pl 3, fig 6

This species has not been recorded from Australia. In July, 1916, I collected several dead valves on the beaches of Lizard and of Eagle Islands

BASSINA PACHYPHYLLA Jonas

Venus pachyphylla, Jonas, Archiv fur Naturgeschichte, 1839, v, (1), p 344, Pl ix, figs 6, 7

This proves to be the earliest name for the species now known as *Venus paucilamellata* Dunker or *Venus alatus* Reeve The illustrations given by Jonas are excellent and readily recognisable though his locality "Patria mare chinense" is of course erroneous At the same place the Australasian species, *Cassia bicarinata* and *Strutholaria sulcata*, are also ascribed by him to China.

Except that this name has been indexed in the Thesaurus and in Jay and Paetel, it has been completely lost by modern authors Even the paper in which it appeared has escaped the Royal Society Catalogue

An unrecorded synonym of the related *Bassina (Callanatis) disjecta* Perry, seems to be *Venus agaricoides* (Brown, MS Cat Bligh Shells, 1822, p 45, No 764 and Mawe, Linn Syst Conchology, 1823, p 46) This comparison also occurred to Tenison Woods who, in his Census, remarked that the undulose frills of *Venus lamellata*, striate on the lower side and of a pink colour, reminded him of the gills of a mushroom

While examining Lamarck's collection in the Geneva Museum, I noticed that his *Venus lamellata*, var 2 (Lamarck, p 598) was not that species but the New Zealand *B. yatei* Gray

PSEUDARCOFAGIA BOTANICA Hedley (Plate xxxi., figs 17, 18, 19)

Tellina fimbriata, Romer, Monogr Tellina, 1872, p 84, Pl 23, figs 4, 5, 6, not *T. fimbriata*, Hanley, 1844—*Tellina decussata*, Angas, Proc Zool Soc, 1877, p 191, not *T. decussata* of Wood or of Lamarck—*Pseudarcofagia botanica*, Hedley, Journ Roy Soc N S W, li, 1918, p M. 25, May, Proc Roy Soc Tasm, 1919, p 68 and Check-list Moll Tasmania, 1921, p 25, and Illustr Index Tas Shells, 1923, Pl xi, fig. 7

The specimen here figured was taken by myself in Middle Harbour, the colour is dull white passing gradually into pale orange at the umbo, the length is 29 and the height 27 mm

On the mainland I trace *P. botanica* from Caloundra, Queensland (Kesteven) to Twofold Bay, N.S. Wales (self). In Tasmania Mr W L May finds that it reaches the east and south coasts and is particularly abundant in the Furneaux group *T. victorise* and *T. botanica* appear as geminate species (see discussion, These Proceedings, xxxv., 1910, p 416 and D. S. Jordan, Bijdr Dierk, xxi, p 175-178), representing one another on opposite coasts

Pseudarcopagia was instituted by Bertan (Nouv Arch Mus., (2), i, 1878, p 204) for a small group of southern Tellinids easily defined by having the sinus confluent with the palhal line. He placed there *T. decussata* Lamarek from Australia and *T. disculus* Deshayes from New Zealand. He expected that the group would soon be increased by the addition of other species, but authors generally have ignored the matter and the present is the first extension of *Pseudarcopagia*.

The first species, which I now nominate as type of the genus, was described as *Tellina decussata* by Lamarek (An s. vert., v, 1818, p. 532) the type locality being King George Sound, W A. As Hanley suggested this type is probably illustrated by the unnamed fig 2, Pl 292 of the Encyclopédie méthodique. Three years before Lamarek wrote, a very different shell, possibly a *Semele*, had been described by Wood (General Conchology, i, 1815, p 190, Pl 43, fig 2, 3 and Index test. 1825, p. 22, Pl 4, fig 81) as *Tellina decussata*. On this account, Gatliff and Gabriel (Vict Nat, xxxi, 1914, p 83) renamed the Australian shell *Tellina victorise*.

PETRICOLA PSEUDOLIMA Soubervie

Petricola pseudolima, Soubervie, Journ de Conch., x, July, 1862, p. 231, Pl. 9, fig 1, *Venerupis texta*, Sowerby, Conch Icon, xix, November, 1874, Pl 2, fig 9.

The type of this species was obtained from Ile Art in New Caledonia by Père Montrouzier *V. texta*, which has not hitherto been recognised as conspecific, was reported from North-East Australia. I have taken it at Green Island, near Cairns.

PSAMMOBIA ROSSITERI Crosse.

Psammobia rossiteri, Crosse, Journ de Conch., xxi, 1873, pp 66 and 129, Pl v fig 6.

The range of this New Caledonian species is now extended to Australia by a single valve which I picked up on the beach of Lizard Island, Queensland, 19/7/16. It was determined by comparison with the type of Crosse which, with Crosse's autograph label, is now in the Australian Museum.

ARGONAUTA BOTTGERI Maltzan (Plate xxxi, fig. 11)

Argonauta bottgeri, Maltzan, Journ de Conch., xxix., 1881, p. 163, Pl 9, fig 7, Smith, Ann Mag Nat Hist., (5), xxi, 1887, p 409, Pl 17, fig. 1-6, Brazier, Cat Austr Cephalopoda, 1892, p 3, Hoyle, Proc Roy Phys Soc. Edinburgh, xiii, 1897, p 365, Hidalgo, Rev. R. Acad Cien Madrid, 1905, p. 9, Dall, Bull Mus Comp Zool, xlii, 1908, p. 226, Berry, Bull Bureau Fisheries, xxxi, 1914, p 277, text-figs 3-7, Pl. 48, fig 5, Massey, Cephal. Terra Nova Exped, 1916, p. 143, fig 1, 2.

Though reported from Australia, no definite locality on our coast has been indicated for this species. It is, therefore, interesting to record that an empty shell, maj diam 38, min diam 21, breadth 16 mm., was collected 18/5/19 on Maroubra beach near Sydney, after a heavy gale, by Mr F. A. McNeill. Perhaps the record by Blainville (Dict Sci Nat., xlii, 1826, p 218) of *Argonauta crassicauda* from New Holland was based on the present species. Our shell has a general resemblance to *A. owenii*, but, as Smith has shown, the rough granular surface provides a good recognition mark to distinguish *A. bottgeri* from the rest of the genus.

The "Albatross" took it off the Hawaiian Islands and the "Terra Nova" met it off the New Zealand coast in about the latitude of Sydney. This distribution suggests that it is a tropical species which has drifted to our beach.

EMARGINULA BAJULA Hedley

Emarginula bajula, Hedley, These Proceedings, xxxviii, 1913, 276

This Sydney species has been reduced by Dr. Thiele (Conch. Cab., 1915, p. 26) to a synonym of the Western Australian *E. dilecta* A. Adams. It was only distinguished from *E. dilecta* after my examination of the type of *E. dilecta* in the British Museum.

With all deference to the valued opinion of the Berlin conchologist, I submit that his conclusion is based on a misapprehension of the identity of *E. dilecta*. By an interrogation mark, Dr. Thiele expresses doubt whether that species is represented by a figure of the type given by the author. Dr. Thiele gives an original figure (Plate 10, figs 13, 14), different in shape, longer in proportion to breadth and with twice as many radials as the type. It is evident that a species different from *E. dilecta* and probably *E. bajula* is here shown.

Perhaps *E. bajula* should be transferred to *Emarginella*.

EMARGINULA DEVOTA Thiele

Emarginula devota, Thiele, Conch. Cab., n., abth. 4a, 1915, p. 81, Pl. 9, figs 27, 28. Type locality, Port Jackson.

This species is an addition to our fauna.

EMARGINULA HEDLEYI Thiele

Emarginula hedleyi, Thiele, Conch. Cab., n., abth. 4a, 1915, p. 74, Pl. 9, figs. 8, 9. Type locality, Port Jackson.—*E. dilecta*, Angas (not Adams), Proc. Zool. Soc., 1867, p. 219.—*E. candida*, Angas, Proc. Zool. Soc., 1877, p. 189, not *E. candida* A. Adams, These Conch., iii, 1863, Pl. 246, figs 45, 46, not *E. candida* Thiele, *op. cit.*, Pl. 8, figs 15, 16, 16a.

This Peronian shell has hitherto been confused with its geminate *E. candida* A. Adams from Port Adelaide. From that it can be distinguished by shorter length, higher arch of back, and blunt, submedian apex.

EURYTROCHUS DANIELI Crosse.

Clanculus danieli, Crosse, Journ. de Conch., x., 1862, p. 407, Pl. 13, fig. 5.—*Trochus danieli*, Fischer, Journ. de Conch., xxiii., 1875, p. 49 and Coq. Viv., 1878, p. 326, 417. Pl. 102, fig. 1.—*Gibbula danieli*, Pilahry, Man. Conch., xi., 1889, p. 229, Pl. 32, figs 57, 58, 58a.—*Gibbula filosa*, Garrett, Proc. Cal. Acad. Sci., iv., 1872, p. 201.

Unrecorded for Australia. I found a single shell on the beach of Lizard Island, 18/7/16.

Eurytrochus was proposed by Fischer (Coq. Viv., Troque, 1879, p. 417) for *Trochus cori* Angas, *danieli* Crosse, *lehmanni* Menke and *ressei* Montrouzier. He afterwards selected (Man. de Conch., 1885, p. 824) *E. danieli* to serve as type. I think that *T. lehmanni* and *bicarinata* Adams (= *cori* Angas) do not agree with this type and suggest that they be withdrawn from *Eurytrochus* and transferred to *Miocula*. In their place I add the following Australian species to *Eurytrochus*,—*Gibbula concinna* Dunker, *Gibbula maccullochi* Hedley, *Trochus plebejus* Philippi and *Gibbula strangi* A. Adams.

CALLIOTROCHUS STRIATULUS Garrett

Trochus striatula, Garrett, Proc Calif Acad, 1, 1857, p 102—*Momile* *striatula* Pictet, Cat, 1, 1887, p 568—*Margarita striatula*, Pilsbry, Man of Conch, xi, 1889, p 249, Pl 61, figs 19, 20, Melvill and Standen, Journ de Conch, viii, 1895, p 126—*Turbo phasianella*, Deshayes, Conchyl de L'île de Réunion, 1863, p 74, Pl 9, fig 13-14—*Trochus phasianella*, Fischer, Journ de Conch, xxii, 1874, p 136 and xxiii, p 49, Coq Vivant, 1879, p 363, Pl iii, fig 4 and p 418—*Gibbula phasianella*, Hedley, Mem Austr Mus, iii, 1899, p 405, not *Turbo phasianella* C B Adams, Panama Shells, 1852, p 195.

Unrecorded for Australia I found a few specimens on the beaches at Eagle Island, at Two-Isles and Rocky-Isle off Cape Flattery, Queensland I have also seen it from Lord Howe Island

MONILEA BELCHERI Philippi

Trochus belcheri, Philippi, Zeitsch. Malak, vi., 1849, p 148, Conch Cab, 1852, p 302, Pl 44, fig 3, Watson, Chall Rep Zool, xv, 1886, p 71

This species has not been recorded from Australia. I found a few specimens in July, 1916, on Rocky-Isle off Cape Flattery, Eagle Island and Lizard Island

ASTRAEA SIRIUS Gould (Plate xxx, fig 1)

Turbo (Stella) sirius, Gould, Proc Bost Soc Nat Hist, iii, 1849, p 83; Hedley, These Proceedings, xxxviii, 1913, p 288

The common Sydney *Astraea* was identified by Angas (Proc Zool Soc, 1867, p 214) as *Uvanilla tentoriiformis* Jonas On re-examination, and with a distrust of the identification of Angas, tried of experience, I now consider that the species of Jonas is a form of South-West Australia, differing by the features of the base from ours In this connection it is noteworthy that most of the marine Australian gastropods handled by Jonas, such as *Astraea aurea*, *Fusus dunkeri*, *F. philippi* and *Cassia bicarinata*, were of South-West origin

In this case our shell will resume the name given to it by Gould.

Following are notes on the animal, to accompany my drawing of the living mollusc Where the water is clear the species is abundant on rocky ground at half-tide level, near Sydney The epipodial fringe is here reduced to a ragged ribbon extending from behind the ocular tentacle to a point half-way to the end of the operculum There are on each side four cirri, three round the operculum and one anterior to it, these are short stumpy little tags Frontal lobes quite absent It is suggested that *Astraea* has degenerated from the *Turbo* type in the direction of *Nerita* The elongate paucispiral operculum is further from the primitive multispiral type than that of *Turbo* The loss of the frontal lobe also indicates a recession from the primitive epipodial development.

Kesteven (These Proceedings, xxvii, 1902, pp 3-5, figs 2, 4, 5) has described and figured the operculum and radula

NERITA MELANOTRAGUS Smith (Plate xxx, figs 4, 5)

For previous notes see These Proceedings, xli, p. 706 The ova of this species has not been described previously They are deposited on shells or stones in small irregular groups of ootheca. Each nidus is from one to two millimetres long, appearing as a small, oblong, hard, white scale On magni-

fication, the cluster is resolved into several hundred, minute, spherical eggs closely packed in a connecting membrane. The whole assumes the shape of an inverted boat attached by the margin. The eggs project from the upper surface, the under side is smooth and glossy. I collected the example figured in Middle Harbour, 9th August, 1917, under stones at mean low tide.

PATELLA ONYCHIUS Menke

Patella onychus, Menke, Moll. Nov. Holland. Spm., 1843, p. 34.

This name has not been recognised by modern students. The suggestion is now put forward that it may be a synonym of *Patelloda septiformis* Quoy and Gaimard, Zool. Astrolabe, 1834, Pl. 71, fig. 43.

CHEILEA UNDULATA Bolten

Patella unaulata, Bolten, Mus. Bolt., 1798, p. 4 for Martini, Conch. Cab., 1, 1767, Pl. xiii., fig. 119, 120 — *Mitralaria neptum*, Schumacher, Essai. Nouv. Syst., 1817, p. 183 for the same figure of Martini and Rumphius, Mus. Tab. 40, fig. P Q — *Calyptraea dormitoria* Reeve, Conch. Icon., xi., 1858, Pl. ii., fig. 5a, 5b.

This seems to be the proper name for a shell erroneously recorded from Australia by various authors as *Calyptraea equestris*. Both Lamarck and Linné confused two species in their references to *Patella equestris*. According to Hanley (Ips. Linn. Conch., 1855, p. 414) that species is characteristically shown by Gualteri, Pl. 9, fig. x.

I have seen *C. undulata* from the Sow and Pigs reef in Sydney Harbour and have gathered it at intervals between the Capricorn Islands and Torres Straits.

CREPIDULA ACULEATA Gmelin (Plate xxx, fig. 6)

Patella aculeata, Gmelin, Syst. Nat., xiii., 1791, p. 3693.

This species is one of the few that range round the whole world. In Sydney Harbour it lives on the under side of stones in the *Eklonia* zone, at or near low-tide level. The animal is uniform buff, the head and mantle with numerous opaque white spots. The hind part of the foot is fast to the shell, but the fore foot is extremely mobile, it can reach out far enough to right itself when the animal is turned over on to its back, sometimes the anterior margin appears truncate, at other times, and as in my drawing, it is emarginate. The muzzle has two projecting lobes which are constant in all attitudes. The tentacles are moderately long, with eyes on the outer side of their swollen base. Intromittent organ behind the right tentacle and usually doubled back. Body much compressed, the sides extending in thin flanges. At the anterior end the mantle forms a short siphon. Ctenidium extremely large, roofing the whole chamber behind the head.

CERITHIUM DORSUOSUM Menke (Plate xxxi, fig. 12)

Cerithium tuberculatum, Menke (not Lamarck), Moll. Nov. Holl. Spm., 1843, p. 19. — *Cerithium dorsuosum*, Menke, Zeitschr. Malak., i., 1844, p. 60, not *Cerithium dorsuosum*, Sowerby, Thes. Conch., ii., 1855, p. 867, Pl. 181, figs. 138, 139, 140 — *Cerithium tuberculatum*, Sowerby (not Linné), Thes. etc., p. 870, Pl. 182, figs. 164, 165, not 162. — *Cerithium janelin*, Hombron and Jacquinot, Voy. Pole Sud, 1842-1853, Moll., Pl. 24, figs. 19, 20; Rousseau, Moll., 1854, p. 104. — *Cerithium variegatum* var. *janellei*, von Martens, Zool. Ergeb. Reis. Niederl.

Ostend., Bd. iv, 1897, p. 171 — *Cerithium janella* var. *moniliferum*, Shirley, Proc. Roy Soc Queensland, xxix, 1917, p. 110

This species is generally distributed on the coast of Queensland as the following records show St Crispin's Reef on the Outer Barrier (McCulloch), Eagle, Hope and Palm Islands (Hedley), Facing Island (Kesteven), Caloundra (Johnston)

CERITHIUM VIGNALI Sowerby

Cerithium vignal, Sowerby, Ann Mag Nat Hist, (8), ix., February, 1912, p. 237, fig. 1, not *Terebraha vignal*, Cossmann, Ess Paleconch comp, vii, 1906, p. 242, Pl. x., fig. 14.

New to Australia. One specimen collected by myself dead on the beach at Lizard Island, North Queensland, 19/7/16

ATAXOCERITHIUM ABBREVIATUM Brazier

Cerithium abbreviatum, Brazier, These Proceedings, i, 1877, p. 316, Melvill and Standen, Journ of Conch, viii, 1897, p. 409 — *Ataxocerithium abbreviatum*, Hedley, Rec Austr Mus, iv, 1901, p. 126, Pl. xvii, fig. 24, Hedley, These Proceedings, xxxii, 1907, p. 481, Not *Cerithium abbreviatum* Deshayes, fide Cossmann — *Ataxocerithium brazieri*, Cossmann, nom. mut., Essai Paleconch Comp, vii, 1906, p. 92, footnote

This species has been reported from Katow, Papua, from Laifu, Loyalty Islands and from Masthead Island, Queensland. Noticing that Brazier's name was preoccupied for an Oligocene fossil, Cossmann has changed it as above. He does not, however, give the original reference on which Deshayes' name depends and I am unable to recover it. Apparently Cossmann's synonymy is based on *Melania abbreviata* DeFrance (Dict Sci Nat, xxix, 1823, p. 467) which is ineffective. Cossmann also (p. 97) extends this genus to New Zealand in the person of a fossil, *Ataxocerithium huttoni* (*Cerith cancellatum*, Hutton, not Lamk.)

BITTIUM LACERTINUM Gould

Cerithium lacertinum, Gould, Proc Bost Soc Nat. Hist, vii, 1861, p. 386; Gould, Otia Conch, 1862, p. 141, Sowerby, Conch Icon, xv., 1865, Pl. xviii., fig. 129, Tryon, Am Journ Conch, ii, 1866, p. 286; Ten Woods, Proc Linn. Soc N S W, ii, 1878, p. 258, Kobelt, Conch Cab, 1898, p. 248, Pl. 43, fig. 7 — *Bittium granarium*, Angas, Proc Zool Soc, 1867, p. 208, Watson, Chall. Rep., Zool xv, 1886, p. 539, Hedley, Proc Linn Soc N S W, xxxix, 1915, p. 718, Pl. 77, fig. 6 (from Gould's type), Not *Cerithium granarium* Kiener, Coq Viv, 1842, p. 72, Pl. 19, fig. 3

Misled by Angas, who asserted that *lacertinum* was the same as *granarium* from Western Australia, subsequent writers have reduced Gould's name to synonymy. Having reconsidered the matter, I find that *lacertinum* consistently differs from *granarium* by less height, greater proportionate breadth and more closely packed grains. I conclude that Gould's *lacertinum* should be resumed for the Sydney shell and that *B. granarium* does not reach the Pacific coast. The species recorded as *B. granarium* from New Zealand is, in my opinion, wrongly identified.

TRIPHORA CANCELLATA Hinds.

Triphora cancellatus, Hinds, Ann Mag. Nat. Hist, xi, 1843, p. 18, Zool. Sulphur, 1844, p. 28, Pl. 8, fig. 6.

New to Australia. Collected by self, 8/8/16, dead on the beach at Rocky-Isle off Cape Flattery, North Queensland.

TRIPHORA CONCINNA Hinds.

Triphora concinna, Hinds, Ann. Mag. Nat. Hist., xi., 1843, p. 20; Zool. Sulphur, 1844, p. 31, Pl. 8, fig. 20

New to Australia. Collected by self, 5/8/16, dead on the beach at Two-Isles, off Cape Flattery, North Queensland.

TRIPHORA DUCOSSENSIS Jousseaume

Mastoma ducosensis, Jousseaume, Bull. Soc. Malac. France, i., 1884, p. 251, Pl. 4, fig. 10

Unrecorded for Australia. I took a few specimens on the beach at Two-Isles off Cape Flattery

TRIPHORA MONILIFERA Hinds

Triphora monilifer, Hinds, Ann. Mag. Nat. Hist., xi., 1843, p. 19, Zool. Sulphur, 1844, p. 30, Pl. 8, fig. 14

New to Australia. Taken by self, 5/8/16, dead on the beach at Two-Isles, off Cape Flattery, North Queensland.

TURRITELLA JOANNAE, nom. mut.

Turritella (Colospira) crenulata, Donald, Proc. Malac. Soc., iv., 1900, p. 52, Pl. 5, fig. 2, 2b, not *Turritella crenulata* Nyst, Descrip. Coquilles Polyp. foss. Belgique, 1843, p. 399, Pl. 37, fig. 6—*Turritella reevei*, Cossmann, Essais Paléoconch. compar., ix., 1912, p. 119, not *Turritella reevei*, Dautzenberg and Fischer, Journ. de Conch., lv., 1907, p. 163

It was noted by Cossmann that a name given to a Sydney shell had served for more than half a century to distinguish an Oligocene fossil from Belgium. Unfortunately he mistook the author of the recent shell who was not, as he supposed, Mr. Lovell Augustus Reeve, but who was Mrs. G. B. Longstaff, formerly Miss Jane Donald. Also he overlooked the fact that the name of *Turritella reevei* was already in use for a shell from Annam. This last error enables me to carry out Cossmann's intention to name it after the talented lady who described the Australian shell.

CYMATIUM PYRUM Linné.

Much learning and skill were brought by Sylvanus Hanley to his analysis of the names in Linnéan conchology. Yet the principles which guided him were so different from the rules which now prevail that some of his conclusions may be reviewed with advantage.

Murex pyrum was founded by Linné (Syst. Nat., x., 1758, p. 749) on the following figures—"Rumf. Mus. t. 26, f. E ?" The "gedroogte peer" was determined by von Martens (Gedenkboek, 1902, p. 116) to be *T. pyrum*; "Gault. test. t. 37, f. 7" The *T. pyrum* of authors, *vide* Hanley; "Argenv. conch. t. 13, f. 7." *T. sarcostoma* of Reeve, *vide* Hanley; "Regenf. t. 3, f. 60." *T. pyrum*, *vide* Deshayes (An. s. vert. ix., 1843, p. 633); "Regenf. t. 5, f. 50" *T. clavator*, *vide* Hanley.

The proposal of Hanley (Ips. Linn. Conch., 1855, p. 290) was to discard the original account of the tenth edition and to decide the identity of *M. pyrum* by the twelfth edition where different characters point to a different shell. On this ground he determined the Linnéan *M. pyrum* as being that shell which Reeve figured as *Triton clavator*.

On the contrary I now suggest that, since Lanné included three different species under *Murex pyrum*, the name should be indicated by the majority of citations and that early writers, such as Dillwyn, were justified in eliminating the other two from the residual which they regarded as *Murex pyrum*. The ruling of Hanley has been generally disregarded.

A fine example of *Cymatium pyrum*, 115 mm in length, was taken by Dr H L Kesteven on the beach of Facing Island, Port Curtis, Queensland. This is the first appearance of the species in Australia, for in recording *C. pyrum* (These Proceedings, xxxiv, 1909, p 451) I had followed Hanley's guidance. An unquoted figure of *C. pyrum* is Hirase, Conchological Magazine, June, 1907, Pl. xii, fig 87.

Both the related species, *C. sarcoctoma* Reeve and *C. clavator* Dillwyn (= *formosus* Perry), occur in Queensland.

NATICA BOUGEI Sowerby

Natica bougei, Sowerby, Proc Malac Soc, viii, 1908, p 17, Pl 1, fig 3.

Some specimens I found cast up on the beach at Rocky-Isle off Cape Flattery, 3/8/16, enable me to add this species to the Australian list.

POLINICES PETIVERIANA Recluz

Natica petiveriana, Recluz, in Chenu, Illustr Conch Lavr, 12-13, 1843, Natica, Pl 2, figs 5-9—*Natica bicolor*, Philippi, Zeitschr Malak, 1848, p 156 and Conch. Cab, p 43, Pl 6, fig 4, Reeve, Conch Icon, ix, 1855, Pl. iv, fig. 17.

This earlier name of Recluz seems to have been overlooked. The species occurs in Queensland and in North-West Australia.

POLINICES SORDIDUS Swainson

Natica sordida, Swainson, Zool Illustr, 1st ser, vol. ii, Pl 79, central figures (Nov ?), 1821—*Natica plumbea*, Lamarck, Anim. s. vert., vi., (2), p 198, April, 1822, Delessert, Recueil, 1841, pl 32, fig 10.

It has long been recognised that *sordida* and *plumbea* were names for the same shell, but which has priority of publication has been left undecided. In 1844 Philippi wrote of *sordida* (Enum mollusc Sierhae, ii, p 140), "Quod nomen prius datum est ? Swainsonii an Lamarckii ?," but without reaching a decision.

Recently it was ascertained by Mathews (Birds of Australia, vii., part v, 1919, p 468) that the "First Series" of the "Zoological Illustrations" were issued in monthly parts with six plates to a part and that part four was dated "Jan. 1, 1821." From this data it can be reckoned that *Natica sordida* was published towards the end of 1821 and has definite priority over *plumbea*.

EPITONIUM BAVAYI de Boury.

Scala (Cirsotrema) bavayi, de Boury, Journ de Conch., ix, 1913, p. 280, Pl 10, fig. 6, previously considered to be *Scala multiperforata*.

New to Australia. Collected by self, dead on the beaches of Rocky-Isle and Two-Isles off Cape Flattery, July, August, 1916.

CYPRAEA CUMINGII Sowerby

Cypraea cumingii, Sowerby, Conch Illustr. Cypræidae, 1832, p. 8, Pl. 1, fig. 5, Hidalgo, Monogr. Cypraea, 1906, p. 325

This species has not hitherto been observed in Australia. One specimen was collected in 1918 by Mr. A. R. McCulloch in 20 fath. off the Endeavour Reef, Queensland

TEREBRA FUNICULATA Hinds

Terebra funiculata, Hinds, Proc. Zool. Soc., 1843, p. 153, Zool. Sulphur, 1844, p. 33, Thes. Conch., i., 1844, p. 168, Pl. 43, fig. 63, Tryon, Man. Conch., vii., 1885, p. 29, Pl. 9, fig. 60 (Pl. 12, fig. 48 is *T. archimedes*, Deshayes, Proc. Zool. Soc., 1859, p. 314, *vide* Reeve, Conch. Icon, xii., 1860)

Unrecorded for Australia. Three specimens collected dead on the beach at Lizard Island, North Queensland by self, 19/7/16, and identified from a New Caledonian specimen named by Mr. Fulton

ENGINA MUNDULA Melvill and Standen

Engina mundula, Melvill and Standen, Journ. of Conch., viii., Oct., 1895, p. 105, Pl. 2, fig. 6

Unrecorded for Australia. I collected several specimens alive under stones on the Outer Barrier Reef near Crescent Reef, 30/7/16

MITRA FULVOSULCATA Melvill

Mitra fulvosulcata, Melvill, Journ. of Conch., v., 1888, p. 287, Melvill and Standen, Journ. of Conch., viii., Oct., 1895, p. 101, Pl. 3, fig. 32

Unrecorded for Australia, one specimen was collected on the Outer Barrier Reef, off Cairns, by Douglas Pitt

PYRENE VERSICOLOR VAR. ATLADONA Ducloux (Plate xxx, figs. 2, 3)

Columbella atladona, Ducloux, Hist. Nat. Coq. Univ., 1840, Pl. 1., figs. 11-12.

The type of *Columbella versicolor* Sowerby, came from the island of Anaa in the Paumotu, a serviceable name for the Sydney expression of this tropical species is var. *atladona* Ducloux. A form from Western Australia, usually united with *versicolor*, but sufficiently distinct for specific recognition, is *Pyrene araneosa* Kiener, 1841 (= *scripta* Lamarck, 1822 (not Linné, 1758) = *bidentata* Menke, 1843). To contain this group Dr. Dall has proposed (Bull. Mus. Comp. Zool., xviii., 1889, p. 187) the subgenus *Euphea*.

In Sydney Harbour, this shell may be found on rocks, but prefers the fronds of the brown sea-weeds, *Sargassum* and *Ecklonia*. The dark colour of the shell conceals it when nestling among the weed. The foot is very narrow and the operculum unguulate.

ZAFRA HERVIERI Pace.

Columbella peasei, Hervier, Journ. de Conch., xlvii., 1899, p. 368, Pl. 14, fig. 9, not *C. peasei* von Martens—*Columbella hervieri*, Pace, *nom. mut.*, Journ. de Conch., i., 1902, p. 420

New to Australia. I found one specimen on the beach at Two-Isles, near Cape Flattery, 5/8/16

ZAFRA OBESULA Hervier

Columbella obesula, Hervier, Journ. de Conch., xlvii., 1899, p. 376, Pl. 14, fig. 6

New to Australia. I found a dozen specimens in shell drift on the beach of Two-Isles, near Cape Flattery, North Queensland, 5/8/16.

ZAFRA STEPHENI Melvill and Standen

Columbella paco, Melvill and Standen, Journ. of Conch., viii., 1896, p. 275, Pl. 9, fig. 5, not *C. paco* E. A. Smith — *Columbella stepheni*, Melvill and Standen, *op. cit.*, p. 407, Hervier, Journ. de Conch., xlvii., 1899, p. 386

Unrecorded for Australia. One specimen from the Great Barrier Reef off Cairns, D. Pitt

DRUPA TUBERCULATA de Blainville

Purpura tuberculata, Blainville, Nouv. Ann. Museum, i., 1832, p. 186, Pl. 9, fig. 3, Kiener, Coq. Viv., Pourpre, 1836, p. 22, Pl. 5, fig. 10 — *Purpura granulata*, Ducloux, Ann. Sci. Nat., Mai, 1832, xxvii., p. 111, Pl. 2, fig. 9

No more definite locality than the original New Holland of Ducloux seems to have been registered. I gathered it alive on rocks at Eagle Island, 23/7/16, and on the Outer Barrier Reef, 30/7/16.

TETHYS ANGASI Sowerby (Plate xxxiii, fig. 21)

Syphonota keraudreni, Angas, Proc. Zool. Soc., 1867, p. 228, Clessin, Conch. Cab., 1899, p. 51, Pl. 12, fig. 4, 5 — *Aplysia keraudreni*, Sowerby, Conch. Icon., xvii., 1869, Pl. 1, figs. 2a, 2b, (not *Aplysia keraudreni* Rang, Hist. Nat. des Aplysiens, 1828, p. 59, Pl. 13) — *Aplysia angasi*, Sowerby, Conch. Icon., xvii., 1869, Pl. viii., figs. 35a, 35b, Angas, Proc. Zool. Soc., 1877, p. 190 — *Tethys angasi*, Pilsbry, Man. Conch., xvi., 1896, p. 101, Pl. 57, figs. 18, 19.

This, the largest and most handsome of our Sea Hares, was first noted in literature by G. F. Angas, who recorded it under the wrong name of *Syphonota keraudreni*; in his revised list of 1877, he substituted for that the name of *Aplysia angasi* Sowerby, type locality, Sow and Pigs Reef, Port Jackson, collected by J. Brazier.

By the kind permission of the Council, I can now, for the first time, illustrate this animal, from a beautiful drawing made more than eighty years ago by Dr. James Stuart, then medical officer at the North Head Quarantine Station. The series, of which this picture is one, was described by Mr. J. J. Fletcher (These Proceedings, xlv., 1921, pp. 609-611).

The original was doubtless taken at the North Head, this species apparently preferring the clear water of the ocean to the estuaries. Our drawing is signed J(amcs) S(tuart), dated (18)41, and labelled "Aplysia." The animal is evidently represented life-size, being 280 mm. in total length and 140 mm. in height, the slug is shown in full marching order, with the lobes of the mantle held aloft, the tentacles exerted and the foot extended. On a dark olive glaucous ground a few large black ocelli are scattered, an impressed network segregates some large tubercles on the upper surface of the foot, the mantle is smooth. The siphon is shown as a funnel the expanded lip of which reaches over the parapodial lobes.

UMBRACULUM BOTANICUM, n sp (Plate xxxii, fig. 20)

Operculatum indicum, Angas, Proc. Zool Soc, 1867, p 228; Schmeltz, Cat Mus. Godeffroy, v, 1874, p 162—*Operculatum aurantium*, Whitelegge, Proc Roy. Soc N.S. Wales, xxxii, 1889, p. 276—*Umbrella indica*, von Martens, Forstch Gazelle, iii., 1889, p 263—*Umbaculum umbella*, Suter, Man. N.Z. Moll., 1913, p 549, Pl. 23, fig 14; Iredale, Proc Malac. Soc., ix., 1910, p. 69, Oliver, Trans N Z Inst, 1914 (1915), p 544, Hedley, Proc. Roy Soc. N.S. Wales, li., 1918, p 108

Shell shield-shaped, rather flat, thin, covered with a caducous epidermis, concentrically striated, irregularly and faintly radially plicate, margin sinuous. Apex on the left side of the centre, prodissoconch erect involute. Colour white, interior scar burnt-sienna to lemon yellow. Foot oval, inflated nearly twice the length of the shell, exposed surface closely covered with tough, erect, compound tubercles. Sole of foot buff-yellow, tubercles lavender-grey, their interstices brown, tentacles and gills buff. Angas reports that a shell collected by himself was four inches long. This is an unusual size.

Hab—N.S. Wales Port Jackson (Angas), Maroubra Bay (type) and Byron Bay (Hedley), Queensland Moreton Bay (von Martens), Bowen (Schmeltz); Lord Howe Island (Thomson), Norfolk Island (Oliver), Kermadec Islands (Iredale), New Zealand (Suter)

This umbrella-shell from the South-west Pacific was determined first by Angas as *O indicum*. But it appears separable from *U indicum*, as figured by Eydoux Souleyet and Gould, by the larger compound tubercles and from *U umbella* Martyn or *smeca* Gmelin by the flatter shell. As the Chinese or Indian umbrella-shells were not well defined by the eighteenth century conchologists who named them, the best way to avoid confusion seems to be to regard the New South Wales form as an independent species until the Oriental species are re-examined.

CHROMODORIS BENNETTI Angas (Plate xxx, figs 7, 8, 9, 10)

Gonodoris bennetti, Angas, Journ de Conch, xii, 1864, p 53, Pl 4, fig 10

This beautiful species is probably the commonest nudibranch in Sydney Harbour. It is sky-blue with a deep orange border to the mantle and spotted with scattered blood-red dots. It lurks on the under surface of large stones in the *Ekloma* zone. Transferred to an aquarium it can swim with the sole of the foot extended on the surface of the water. The rhinophores are pink. The branchiae are rose on the inner and outer sides, the rest white, they are furnished with nine bipectinate branches and are completely retractile.

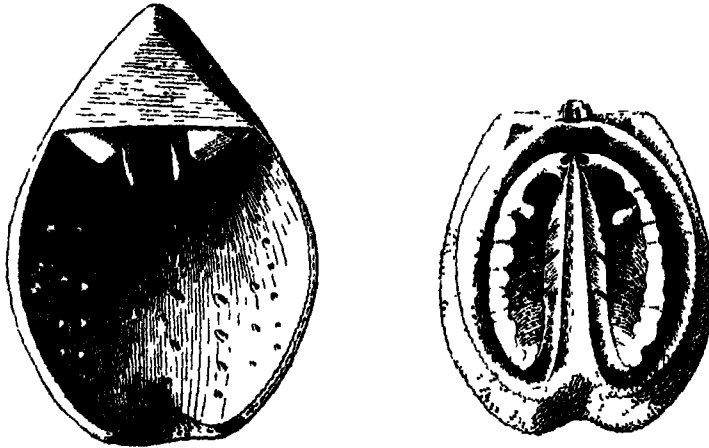
One of these nudibranchs which I kept in a basin of water laid a coil of eggs on November 24th. The ribbon was in a spiral which rapidly enlarged and almost formed a closed circle. The orange eggs were imbedded in a translucent gelatinous frame twice as high as broad.

Dr. Bergh has given some anatomical details of this. (Verhandl. k.k. Zool. bot. Ges. Wien., 1893, p 415, Pl. iv., f. 12-17).

THECIDELINA MAXILLA Hedley. (Text-fig. 1)

Thecidea maxilla, Hedley, Mem. Austr. Museum, iii., 1899, pp 508-510, text-fig. 57; Mawson, Proc. Linn. Soc. N.S. Wales, xxx., 1905, p 477—*Thecidelina maxilla*, Thomson, Geol. Mag., Dec. vi., Vol. ii., Oct., 1915, p. 463.

A single top valve, dredged by myself in 5-8 fathoms, off Murray Island, Torres Straits, adds another genus to the Australian brachiopoda.

Text-fig. 1. *Thecidellana mazilla* Hedley

EXPLANATION OF PLATES

Plate xxx

- Fig 1 — *Astraea sirius* Gould, animal from life
 Fig 2 — *Pyrene versicolor* Sowerby var *atladona* Duclos, animal from life
 Fig 3 — Operculum of same
 Fig 4. — *Nerita melanotragus* Smith, egg masses laid on a pebble
 Fig 5 — A single egg mass of the above, enlarged
 Fig 6 — *Crepidula aculeata* Gmelin, animal from life
 Fig 7 — *Chromodoris bennetti* Angas, animal from life
 Fig 8. — Rhinophore of same enlarged
 Fig 9 — Branchiae of same enlarged
 Fig 10 — Egg mass of same

Plate xxxi

- Fig 11 — *Argonauta bottgeri* Maltzan
 Fig 12 — *Cerithium dorsuosum* Menke
 Fig 13. — *Hemidonax dactylus* Hedley, type.
 Fig 14 — *Pitaria inconstans* Hedley, type
 Fig. 15 — Hinge of same
 Fig 16 — Dorsal view of same enlarged
 Fig 17 — *Pseudarcopagia botanica* Hedley
 Fig 18 — Hinge of same
 Fig 19 — Enlarged sculpture of same

Plate xxxii.

- Fig 20 — *Umbraculum botanicum* Hedley, type.

Plate xxxiii

- Fig. 21. — *Tethys angasi* Sowerby

A REVISION OF THE AUSTRALIAN SPECIES OF THE GENUS *BASSIA*

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Sydney

(Plates xxxiv-xxxvi)

[Read 23th July, 1923]

Introductory

While working on some material from the Broken Hill District I was impressed by the state of confusion which apparently existed in the Family Chenopodiaceae. The exigencies of the moment forced me more particularly into the genus *Bassia*, and I quickly came to the conclusion that a complete revision of the Australian members of the genus was necessary. During the past eighteen months I have laboured to this end, and am now submitting a paper which, I trust, will do something towards straightening out a very chaotic genus.

In this work I have been greatly assisted, in various ways, by the Director, Mr. J. H. Maiden, F.R.S., and by my fellow members of the staff, Messrs. E. Cheel, W. F. Blakely and J. N. Whittet. Mr. Landlaw, Government Botanist of Victoria, has greatly aided me by supplying, from the National Herbarium, types and other material, without which it would have been impossible to form definite decisions. Mr. C. T. White, Government Botanist of Queensland, was also kind enough to place all his material at my disposal. Above all my thanks are due to Mr. J. M. Black of Adelaide who has assisted me in every way possible. We discovered that both of us were simultaneously working on the same genus, and, although Mr. Black had been studying the group for a long time, he co-operated with me in a very courteous and helpful manner. I am indebted to Miss E. King for the figures of the fruiting perianths included in the plates.

I have, in the main, followed Volken's classification in Engler and Prantl (*Pflanzenfamilien*), but have added to and modified the various sections there arranged under *Bassia*. The great bulk of Australian material was not available to Volken, whose classification, therefore, could only be provisional.

I feel that, so far as species are concerned, the material at my disposal has been fairly thoroughly worked out, but the limitation of the genus and its sections is still a matter largely of opinion.

Differences within the genus are at times so pronounced that one might be

inclined to split up the genus, making the sections distinct genera. It does not, however, seem advisable to follow this course, as the various species are obviously allied and connecting links between sections are not wanting. I have, however, excluded several species hitherto included in the genus.

Historical.

The genus *Bassia* was established in 1766 by Allioni (*Mélanges de philosophie et mathématique de la Société Royale de Turin*, iii., p. 177, t. 4). A fairly comprehensive description was given, a translation of which will be found later in this paper (see p. 320), the type species, *Bassia muricata* All., being from Egypt. Five years later, in 1771, the name *Bassia* was also given to a genus in the Sapotaceae by Koenig (ex Linné Mant., ii., App. 555).

The priority of Allioni's name is thus clearly established, but later botanists accepted Koenig's genus, placing Allioni's genus under subsequently described genera. The following genera in chronological order of establishment are now regarded as synonyms of the genus *Bassia* —

Willemetia Maerkl, in Schrader, Journ. Bot., iii., 1, 1800, 329

Amsacantha R. Br. Prodr., 1810, 410

Sclerolaena R. Br. Prodr., 1810, 410

Willemetia Moq., in Ann. sc. nat., 2 sér., i., 1834, 206 t. 6

Echinopsilon Moq., Ibid., ii., 1834, 127

Londesia Fisch. et Mey. Index sem. Horti petropol., ii., 1835, 40

Kentropsis Moq. Chenopod. enum., 1840, 83

Maureana Moq. Chenopod. enum., 1840, 95

Centropsis Endl. Gen. Suppl., ii., 1842, 33

Eriochiton F. Muell. Second Gen. Report, 1854, 15

Osteocarpus F. Muell., in Trans. Phil. Instit. Victoria, ii., 1858, 75

Endlicher (Genera Plantarum, 1836-1840, 1927, p. 296), placed *Bassia* All. under *Echinopsilon* Moq. In 1849 De Candolle still retained *Bassia* All. under *Echinopsilon* Moq. and kept separate the genera *Amsacantha* and *Sclerolaena* established by Brown. In 1867 Bossier* made *Bassia* a section of *Koehia* Roth in the Flora Australiensis (Vol. 5, 1870), Bentham made no recognition of *Bassia* All., but maintained the genera *Amsacantha* R. Br., *Sclerolaena* R. Br., and *Chenolea* Thunb. Bentham and Hooker in 1860 (Genera Plantarum, iii., p. 60) placed *Bassia* All. under *Chenolea* Thunb. in the section *Echinopsilon*, maintaining *Sclerolaena* R. Br. and *Amsacantha* R. Br. as separate genera.

In 1882 Mueller (First Census of Australian Plants) re-established the genus *Bassia*, uniting under it the genera *Chenolea*, *Sclerolaena*, *Amsacantha*, *Echinopsilon*, *Kentropsis*, *Dissocarpus*, *Eriochiton*, *Osteocarpus* and *Collocarpus*. In the same year, he pointed out (Fragm., 12, p. 12) the claims of Allioni's genus to priority and re-established *Ilkpe* Koenig in the Sapotaceae, sinking *Bassia* Koenig as a synonym.

In 1887 Schweinfurth and Ascherson (Illustration de la Flore d'Égypte, p. 127) likewise re-established the genus *Bassia* All., but giving it somewhat narrower limits than those assigned by Mueller. Prof. Baillon in the same year (Histoire des Plantes Chenopodiées, 1877, 177) also recognised the genus.

In 1880 Mueller (Viet. Nat., v., 98) drew attention to the work of Drs. Ascherson and Schweinfurth, and to that of Prof. Baillon. In the same year

* I have not seen the work of Bossier but believe it is the "Flora Orientalis"

the "Iconography of Australian Salsolaceous Plants" was published in which Mueller figured the various species under *Bassia*.

In 1891 Kuntze (*Revisio Generum Plantarum*, Part 2, p. 546) recognised the genus *Bassia* All., and also placed under it *Chenolea* Thunb. He also pointed out that if one would follow Bossier in his limitation of the genus, in which he placed *Bassia* as a section of *Kochia*, we would have to reverse the order and place *Kochia* as a section of *Bassia*.

The genus *Kochia* was not established until 1800 by Roth (*Schrad Journ Bot*, 1800 (1801), 1, 307, t. 2), so Kuntze's contention is correct. He also drew attention to the work of Mueller in transferring all the Australian species to the genus *Bassia*.

In 1893, Volkens (*Pflanzenfamilien*, in Teil, 1 Hälfte, Abteilung a, p. 70) maintained the genus *Bassia* All. but kept *Chenolea* Thunb. as a separate genus. He gave a short description of the genus and made 4 sections, namely, *Echinomylon*, *Anisacantha*, *Dioscarpus*, and *Maureana*. In the *Index Kewensis* (1893, p. 277) *Bassia* All. is given as a synonym of *Chenolea* Thunb. In the "Genera siphonogamarum" (1900-1907, p. 144) Torre and Huus gave a comprehensive review of the genus and its synonyms, including the sections.

In 1912 Muschler (*Manual Flora of Egypt*, 1, p. 269), evidently following Bossier, placed the members of the genus *Bassia* under *Kochia*. But *Bassia* All. is now generally recognised by botanists as an established genus, although differences of opinion exist as to its limitations. Merrill (*Philippine Journ Sc*, 10, 1915, p. 56) maintained the genus *Bassia* Koenig in the Sapotaceae, but was evidently unaware of the existence of *Bassia* All. Maiden and Betcher (*Census of N.S.W. Pl.* 1916, p. 68) follow the sections outlined by Volkens, the species being grouped accordingly. C. T. White (*Qld Agric Journ*, May, 1921, p. 218) gives a brief survey of the genus under "Notes on the Genus *Bassia*."

The genus *Bassia* All. is thus generally recognised by present day botanists as a well established genus, but its exact limitation is still a matter largely of opinion. It embraces species which appear to be generically distinct but between extreme forms there are always connecting links so that a satisfactory splitting up of the genus would be very difficult. The section *Maureana* might perhaps be given generic rank as a genus intermediate between *Kochia* and *Bassia*.

FAMILY CHENOPODIACEAE

Division *Cyclolobae-Camphorosmeae*

Bassia All., *Misc taurin*, in (1766), 177, t. 4

Flowers hermaphrodite. Perianth hirsute, rarely glabrous, urceolate, globular, or depressed, with 4-5 short, inflexed or erect lobes, usually hardened but sometimes membranous on the fruit and with 2 or more erect, outwardly spreading, or recurved spines. Styles 2-3, connate at the base, thread-like. Stamens usually 5, occasionally fewer. Fruit enclosed in the perianth, ovoid, globular or depressed. Pericarp membranous. Seed globular or compressed, vertical, horizontal or oblique. Embryo annular or almost so, surrounding a mealy albumen, radicle usually erect or ascending. Testa membranous. Undershrubs, shrubs, or occasionally annuals, prostrate, decumbent or erect, usually divaricately branched. Leaves alternate, rarely opposite, usually linear or lanceolate but in some species very broadly lanceolate to rhomboid. Flowers solitary or in clusters, usually in the axils of the leaves. Fruiting perianth usually closely sessile.

The species are distributed in Middle Europe, North Africa, Temperate Asia, but most abundantly in Australia. In this revision 42 species are recorded for Australia, the majority of which are to be found under dry and conditions. A few species, however, occur in more temperate localities and on richer soil.

The following is a translation of the original description by Allioni which is very difficult to obtain.

'This new genus of plants for which I have instituted the name *Bassia*, has a terete, branching, fibrous, perennial root, a round stem, not very stout, and branching continuously and intricately, the branches branching in like manner again. The first branches of the stem are almost decumbent. The whole plant is villous hirsute, equal in height to 1-2 spans. The leaves are linear lanceolate, thick compressed, sessile, alternate, or rather densely and irregularly placed, usually of 2 kinds one of which is longer than the other, and with 2 sessile flowers present in its axil. The other is shorter, with one sessile flower, and with a bundle of leaves making a new branch. All flowers are sessile in the axils of the leaves. The flower is apetalous, calyx monophyllous, five times divided into acute segment. Stamens five, bearing the yellow didymous anthers above the calyx. Styles 2, filiform, from white to purple, arising from the embryo. When in flower, however, the flat coalescing segments of the calyx enclose the flower, and the calyx becomes the capsule, containing when mature the orbicular seed of indistinct colour, not cochleate, but having on the upper surface a circular engraved groove. In that portion in which the embryo is of larger size, the receptaculum is extended to greater dimensions, and at the base of the calyx 5 yellowish spines appear, situated at equal distances from one another. The calyx, becoming thickened, firm, and coriaceous, forms the rounded flattened fruit, having 5 firm spines radiating from its circumference. This genus lies between *Chenopodium* and *Salsola*. But from both it differs, especially in the changing of the calyx to the capsule. On account of this it seems to be worthy of establishment as a genus, and I have named it *Bassia* as a token of my friendship, gratitude, and esteem, for the most learned Ferdinand Bassum of Bonn."

In dividing the genus into sections I have adopted the 4 sections of Volkens, but have established two additional ones.

SECTION I *ECHINOPYLON* Hook f. in Bentham and Hooker, *Genera Plant*, III, 1880, 60 (Sect. *Chenoleae*), Volkens, Engler et Prantl, *Pflziam*, III, 18, 1893, 70.

This section includes *Willemetia* Maerkl., *Willemetia* Moq., *Echinopylon* Moq., *Londesia* Fisch et Mey.

Floral envelope remaining membranaceous or very slightly hardened, the spines (occasionally reduced to small protuberances) arising on the top of the three lobes of the floral envelope, or directly under these. In this section are included mainly the Arabian and Egyptian species.

After some hesitation I decided to place in this section the four Australian species, *B. densiflora* W. V. Fitzg., *B. Muelleri* (Benth.) F. v. M., *B. eurotioides* F. v. M., and *B. astrocarpum* F. v. M. in which the perianth is only slightly or not at all hardened. The other species, e.g., *B. Tatei* F. v. M. and *B. eriakantha* (F. v. M.), in which the perianth is only slightly hardened, I have placed in Section III (*Amsacantha*), but they might perhaps be gathered together, leaving only the species with much hardened perianths in Section *Amsacantha*.

The Egyptian species *B. muricata* All., which Volkens quotes as an example in the section *Echinopylon* (Engler and Prantl, *Pflzfam*, III, 18, 70), has certainly a slightly hardened base and perianth.

SECTION II *ERIOCHITON*.

I am proposing this as a new section. It resembles Sect. *Echinopylon*, but

the perianth, in addition to the spines, bears 5 dorsal erect membranous appendages, resembling, in this respect, some species of *Koehia*.

The section includes the genus *Eriochiton* F.v.M. (See Gen Rept, 1854, 15) and is represented by a single species, *B. sclerolaenoides* F.v.M.

SECTION III *ANISACANTHA* Volkens in Engler and Prantl, Pfizfam., III, 12, 1893, 70

This section includes *Anisacantha* R.Br., *Sclerolaena* R.Br., *Kentropsis* Moq. and *Centropsis* Endl.

The floral envelope hardens at the base, developing with the fruit, forming a hard fruiting perianth, bearing the spines. Seed vertical, horizontal or oblique.

This section includes the great majority of the Australian species.

SECTION IV *DISSOCARPUS* Volkens, Engler and Prantl, Pfizfam., III, 12, 1893, 70

This section includes *Dissocarpus* F.v.M. The flowers grow together in a cluster, the fruits subsequently forming a hard mass of 2 to many united individuals.

This section includes 3 Australian species, *B. biflora* (R.Br.) F.v.M., *B. paradoxu* (R.Br.) F.v.M. and *B. spinosa* F.Wart. and Davies.

SECTION V *PLATYACANTHA* F.v.M., Fragm., 12, 1882, p. 12

In his description of *Bassia tridens* F.v.M., Mueller writes — "The species merits a separate section under the name of *Platyacantha*, unless it remains with the preceding species (*B. Forrestiana*) in *Anisacantha*." Fruiting perianth with broad flattened spine-like appendages, both spines and perianth hardened.

The section is quite a distinct one, and contains only one species, *Bassia tridens* F.v.M. It approaches the next section, *Maireana*, in some respects, but differs in the regular well-defined spines, and the absence of the horizontal expansion.

SECTION VI *MAIREANA* Volkens, Engler and Prantl, Pfizfam., III, 12, 1893, 70

This section includes *Maireana* Moq. It resembles Section *Anisacantha* but the hardened fruiting perianth develops a small wing-like border or horizontal expansion, the edge of which is broken up into spines. A connecting link with *Koehia*.

This section includes 3 Australian species, *B. stelligera* F.v.M., *B. Luehmanni* F.v.M., and *B. brachyptera* (F.v.M.) nov. comb. *B. microcarpa*, n.sp., also has certain affinities with this section.

Key to the Sections

- 1 Perianth remaining membranous, not at all or very slightly hardened in the fruiting stage
- 2 Fruiting perianth with erect membranous appendages in addition to the spines. Sect. II *Eriochiton*
- 2a Fruiting perianth without any appendages other than the spines. Sect. I. *Echinopylon*
- 1a Perianth becoming hardened from the base, usually much hardened in fruit
- 3 Flowers clustered, the fruiting perianths connate into a hard mass of two to many fruits. Sect. IV *Dissocarpus*
- 3a Flowers solitary, the fruiting perianths not connate
- 4 Fruiting perianth bordered by a narrow rim or wing-like expansion, broken up into spines. Sect. VI *Maireana*
- 4a Fruiting perianth without any wing-like expansion, spines present

Series 2

- 1 Spines of the fruiting perianth 2-4 in number (Sometimes 5-spined in *B. decurrens*)
 - 2 Whole plant, except the flowers, glabrous or almost so
 - 3 Longest spine more than 15 mm. and up to 35 mm long Usually 4 spines, 2 of which are more or less reduced 14 *B. longicauspis* F v M
 - 3a Longest spine usually less than 15 mm long
 - 4 Spines usually 2 in number, more or less equal, or with 1-2 shorter spines or tubercles
 - 5 All spines very short, the longest less than 5 mm long
 - 6 Spines usually recurved, 4 in number, the longer pair opposite and diverging, the shorter pair approximating each other at their base 11 *B. recurvicauspis* W V Fitz
 - 6a Spines not recurved, usually 2 in number, with a 3rd very short spine or tubercle 12 *B. glabra* F v M.
 - 5a Longest spine more than 5 mm and up to 15 mm long
 - 7 Limb twice as long as the tube of perianth Spines 2 with a short tubercle, or with a 3rd small spine 13 *B. bicuspis* F v M
 - 7a Limb not as long as tube Spines 3-4 18 *B. Drummondii* (Benth.) F v M.
 - 4a Spines 3, rarely 4, more or less equal, or with a fourth very short one
 - 8 Fruiting perianth attached by a very oblique base Spines 3 with a fourth much reduced Limb recurved 15. *B. dinaricata* (R Br.) F v M
 - 8a Fruiting perianth attached by a broad distended base Spines 3 or very occasionally 4 all more or less equal Limb erect 16 *B. tricuspis* (F v M), n comb
- 2a Plants pubescent, hirsute or tomentose
 - 9 Fruiting perianth enveloped in long silky hairs 17 *B. lanicauspis* F v M
 - 9a Fruiting perianth tomentose shortly hirsute or almost glabrous
 - 10 Limb equal to the length of tube or almost so Spines in pairs with 1-3 much smaller ones decurrent on one spine Tube prominently ribbed 19 *B. decurrens* J M Black
 - 10a Limb much shorter than the tube
 - 11 Fruiting perianth with 3-4 spines, 2 of which are more or less equal the others smaller 18. *B. Drummondii* (Benth.) F v M
 - 11a Fruiting perianth with 2 spines, usually with a small tubercle at the base of one
 - 12 Spines of the fruiting perianth spreading outwards in the same vertical plane Limb fairly well produced 21 *B. patenticauspis*, n sp
 - 12a Spines of the fruiting perianth spreading outwards but twisted in different directions, not in the same vertical plane Limb much reduced Base of fruit much furrowed 20 *B. obliquicauspis*, n sp
- 1a Spines of the fruiting perianth 5-6 in number, or 4 with one spine bifid
 - 13 Spines 5, or 5, with the fifth bifid Fruiting perianth oblong, small, rarely more than 3 mm long, ribbed or striate and produced at the base into 2 short spurs Leaves usually short, linear, glabrous or hirsute 22. *B. echinopisila* F v M
 - 13a Spines 5, or 4, with the fourth bifid Fruiting perianth cylindrical or depressed, without any spurs at the base

- 14 Fruiting perianth depressed, irregular in shape, or shortly cylindrical, the tube rarely more than 2 mm long 25 *B. quinquecuspidata* F.v.M.
 14a Fruiting perianth cylindrical or conical, the tube usually more than 3 mm long
 15 Base of mature perianth hollowed, slightly oblique Leaves and branches densely or sparingly hirsute or tomentose Branches slender, ascending . 23 *B. tubata*, n.sp.
 15a Base of mature perianth not hollowed, very oblique Leaves and branches glabrous, except for tufts of hairs in the axils of the leaves Branches very intricate 24 *B. intricata*, n.sp.

Series 5

- 1 Spines of the fruiting perianth 2-4 in number (Rarely 5-spined in *B. ventricosa* and *B. Forrestiana*)
 2 Fruiting perianth always 3-4-spined (or occasionally 5-spined in *B. ventricosa* and *B. Forrestiana*), hirsute or tomentose
 3 Longest spines of the fruiting perianth more than three times the length of the tube and up to 25 mm long Leaves densely hirsute and up to 3 mm long 26 *B. Forrestiana* F.v.M.
 3a Longest spine of the fruiting perianth barely twice as long as the tube, rarely exceeding 6 mm Leaves hirsute, but becoming almost glabrous 27 *B. ventricosa* J.M. Black
 2a Fruiting perianth usually 2-spined, but often with a third spine on one face densely woolly tomentose
 4 Tube rarely more than 3 mm long, the limb almost or quite equal to the length of the tube Whole plant always hirsute or tomentose 28 *B. limbata* J.M. Black
 4a Tube more than 3 mm long, the limb usually much shorter than the tube Older leaves often becoming glabrous or almost so 29 *B. bicornis* (Lindl.) F.v.M.
 1a Spines of the fruiting perianth 5-6, or 4 with one spine bifid
 5 Spines of the fruiting perianth usually 6, or 5 with one spine bifid
 6 Fruiting perianth large, always more than 3 mm and up to 6 mm in diameter at the top Spines up to 6 mm long Plant woolly tomentose 30 *B. Cornishiana* F.v.M.
 6a Fruiting perianth small, under 3 mm in diameter, the spines 1-3 mm long Plant densely or sparingly hirsute
 7 Leaves invested with dense long hairs Fruiting perianth very small the longer spines under 1 mm long and sharply hooked at the end 35 *B. microcarpa*, n.sp.
 7a Leaves sparingly hirsute Fruiting perianth small, the longer spines usually exceeding 1 mm in length and not hooked 33 *B. parviflora*, n.sp.
 5a Spines of the fruiting perianth 5, or 4 with one spine bifid
 8 Fruiting perianth readily detached from the stem, the tube narrowing to a regular circular base
 9 Fruiting perianth tomentose, the top domed, the spines somewhat ascending . 32 *B. convexula*, n.sp.
 9a Fruiting perianth glabrous or slightly hirsute, the top flat, spines horizontal or slightly recurved Tube strongly ribbed 34 *B. costata*, n.sp.
 8a Fruiting perianth detached with difficulty from the stem, the tube very irregular, the base usually oblique
 10 Plant glabrous or villose, scarcely robust. Leaves linear, lanceolate, or somewhat obovate 25 *B. quinquecuspidata* F.v.M.

10a Plant woolly tomentose, robust, Leaves obovate

31 *B. Birchii* F v M

Section IV DISSOCARPUS

1 Connate fruiting perianths always furnished with spines, usually very spiny (Occasionally the spines reduced to obtuse horns in *B. paradoxa*)

2 Fruiting perianths 6 or more in the head, the spines simple

37 *B. paradoxa* (R.Br.) F v M

2a Fruiting perianths less than 6 in the head, the spines stronger and usually divided 38 *B. spinosa* Ewart & David.

1a Connate fruiting perianths usually without spines, or with 1-3 short spines or tubercles Fruiting perianths 2-6 in the head 36 *B. biflora* (R.Br.) F v M

Section V PLATYACANTHA

Spines 3, with one bifid, much flattened, and somewhat united at their base Base of tube usually hollow . 39 *B. tridens* F v M.

Section VI MAIREANA

1 Horizontal expansion of the fruiting perianth irregularly broken up into spines or spine like segments

2 Tube globose or globose truncate, more than 1 mm in diameter Leaves linear 41 *B. stelligera* F v M

2a Tube very short and almost flattened, less than 1 mm long Leaves rhomboidal, tapering into a long narrow petiole-like base

40 *B. Luehmanni* F v M

1a Horizontal expansion not broken up but marked by 5 regularly placed, very short spines Leaves with long dense hairs

42 *B. brachyptera* (F v M), n comb

1 BASSIA EUROTIODES F v M

Echinopylon eurotoides, F v M. Fragm., vii, 1869, 13—*Chenolea eurotoides*, F v M, B Fl., i, 1870, 191—*B. eurotoides*, First Census, 1862 Viet Nat., v, 1889, 98, Icon Austr. Salsol., Plate lxxxi

Notes additional to the description—Spines reduced to 3-6 slender awns, tapering from a rather broad and somewhat thickened base Perianth domed Awns up to 15 mm long Vestiture on older branches considerably reduced.

Affinity—This species shows closest affinity with *B. densiflora* W V Fitz which differs in the shorter rigid spines, and the shorter vestiture on the fruiting perianth

Range—So far as we know it is confined to Western Australia The following localities are represented in the National Herbarium—Nannine, Boulder, Comet Vale, and between Kununoppin and Mt Marshall, and Lake Barlee

2 BASSIA DENSIFLORA W V Fitz.

Mueller Bot Soc., 1904, 31

Notes additional to the description—A low spreading shrub densely invested with white silky hairs Perianth lobes usually 4, forming a square shaped top to the fruiting perianth and each bearing at the corner a spine one of which is generally bifid Spines slender, more or less equal, up to 6 mm long, occasionally 6 in number Leaves clothed in longer hairs (up to 15 mm) than the fruiting perianth Branches at times only sparingly hirsute

Affinities.—1 With *B. eurotoides* (See previous species) 2 In its

general superficial appearance it resembles *B. lunicusps*, but differs very considerably in the nature of the fruiting perianth.

Range.—Apparently confined to Western Australia. The type specimens are from Nannine (W. V. Fitzgerald 9/1903) and Gwalia (W. V. Fitzgerald 11/1903). Both of these are represented in the National Herbarium, and in addition specimens are present from Mullewa, (near Laverton), and Cowcowing (Mixed with *B. eurotioides* F. v. M.).

3. *BASNIA MUELLERI* (Benth.) F. v. M.

Chenolea Muelleri, Benth., B. Fl., v., 1870, 191.—*B. Muelleri*, First Census, 1882, Fragm., xii, 1882, 13.

The only specimen I have seen belonging to this species is the type from Sturt's Creek (Mueller).

The inflorescence and leaves are clothed in long silky hairs, the vestiture on the branches being much shorter. Leaves up to 15 mm long by 1½-2 mm wide. Spine 4-5, short, stout, the longest 2-2½ mm long. Perianth very small, barely 2 mm long. The styles appear to be more commonly 3 in the specimen examined—Bentham gives the styles as 2 (B. Fl., v, 191). The seed, though not mature, is more inclined to the vertical than the horizontal, although Bentham describes it as horizontal or oblique.

I have placed this species in the Section *Echinopsilon* as the perianth apparently remains membranous, but mature fruits have not yet been found.

It is an imperfectly known species, and more material is necessary for its satisfactory definition.

W. V. Fitzgerald has recorded it from Broome, W. A. (Bot. of the Kimberleys, Journ. Proc. Roy. Soc. W. A., iii, 1918, 36).

4. *BASNIA ASTROCARPA* F. v. M.

Chenolea astrocarpa, F. v. M., coll. 1 *B. astrancantha* F. v. M., First Census, 1882, 140.—*B. astrocarpa*, Fragm., xii, 1882, 12, Second Census, 1889, Icon. Austr. Salsol., Plate lxx.

The following is a translation of the original description.—“Silky-tomentose, leaves somewhat short semiterete-linear or the upper ones more lanceolate, acute, scarcely narrowed at the base. Spines of the fruiting calyx 5, conspicuously shorter than the tube, slightly unequal, tomentose, pubescent underneath, the tube about twice as long as broad, slightly hollowed at the base, the seed vertical. In the neighbourhood of Nichol Bay, Crouch. A somewhat harsh shrub. Leaves often between 3 and 5 lines long, intermingled towards the tops of the branches with the fruits, often closely crowded. Tube of fruiting calyx about 2 lines long, spines diverging almost in a stellate fashion, scarcely exceeding, or shorter than a line. Approaches *B. Muelleri*, differing in the more lax vestiture, the crowded flowers, but chiefly in the length of the fruiting calyx, and perhaps in the position of the seed. But I have not the mature fruit of *B. Muelleri*. Styles of this plant often 3” (F. v. M., Fragm., xii, 12).

Additional notes.—Spines 2-3 mm long. Tube of the fruiting perianth up to 5 mm. long by 2 mm. in width. Leaves up to 15 mm. long. A species readily distinguishable by the long tube and the 5 short spines.

Mueller included it in the section *Amisacantha*, but the scarcely hardened perianth seems to bring it into *Echinopsilon*.

Affinity—This species approaches *B. recurvicauspis* W. V. Fitz, but differs in the softer character of the perianth, and the number and nature of the spines.

Range—Apparently limited to Western Australia. Specimens from Broome and Goodygoody are included in the National Herbarium.

5. *BASSIA SCLEROLAENOIDES* F. v. M.

Eriochiton sclerolaenoides F. v. M., Second Report, 1854, 15 — *Echinopsilon sclerolaenoides* F. v. M., Trans. Phil. Inst. Vic., ii, 1858, 75; *Fragm.*, vii, 1860, 13 — *Chenolea sclerolaenoides* F. v. M., in *B. Fl.*, v, 1870, 192 — *Chenolea Dallachyana* Benth., *Fl.*, v, 1870, 101 — *Bassia Dallachyana* (Benth.) F. v. M., First Census, 1882 — *B. sclerolaenoides*, First Census, 1882, *Fragm.*, xii, 1882, 12; *Icon Austr. Salsol.*, Pl. lxxxii — *Bassia eriochiton* Tate, *Flora S. A.*, 1890, 51.

Notes additional to the description in B. Fl., v, 192 — Fruiting perianth enveloped in dense wool which often conceals the spines. Spines up to 7 mm long. Leaves up to 15 mm long but usually much shorter. Styles usually 2, connate at the base, but occasionally 3, or the third much reduced.

This species is quite distinct from other members of the genus by reason of the erect membranous appendages. These are also found in some species of *Kochia*. The scarcely hardened perianth places it in the *Echinopsilon* section, but the membranous appendages warrant its being made a separate section.

Synonym — *B. Dallachyana* (Benth.) F. v. M., First Census, 1882. *Chenolea Dallachyana* Benth., *Fl.*, v, 1870, 101.

A considerable amount of confusion has existed as regards the above species. The material in the National Herbarium labelled *B. Dallachyana* proved to be *Kochia eriantha* F. v. M. or an allied species of *Kochia*, and the confusion apparently existed in other States as well.

All the material had well developed wing expansion, usually irregularly separated into 5 lobes or segments, the whole fruiting perianth being concealed under long dense hairs. Such material has no affinity either with the description or type specimen of *B. Dallachyana* (Benth.) F. v. M.

A close examination of the type specimen (Murray Desert, Dallachy) shows that it can hardly be separated from *B. sclerolaenoides* F. v. M., and Mueller in the unpublished manuscript of his Third Census considered it a synonym of *B. sclerolaenoides* F. v. M.

Benthum in his key (*B. Fl.*, v, 1870), distinguishes the two species by the absence of appendages to the fruiting perianth of *B. Dallachyana*, but remarks that the fruiting perianth may not be quite ripe.

The perianths of the type were very immature, as in no case could I find mature, or even immature seeds developed. The flowers, vestiture, and general habit closely resembled those of *B. sclerolaenoides* F. v. M. and the absence of the appendages might possibly be due to the undeveloped condition of the perianth.

It would seem that, at present, there is insufficient evidence to distinguish the two species.

Should additional material show that the appendages are always wanting in *B. Dallachyana*, then the species would have to be transferred from the genus *Bassia*, probably to the genus *Chenolea* Thunb.

Range.—Found in arid parts of Western Australia, South Australia, Vic-

toria and New South Wales. The following localities are represented in the National Herbarium—*Western Australia* Coolgardie, Nannine, Victoria Desert Camp 53 *South Australia* Murray River, Port Pirie, Mount Lyndhurst, Mooolooloo Station *New South Wales* Broken Hill, Barrier Ranges *Victoria* Ouyen

(6) *BASSIA ERICANTHA* (F & M), n comb

Kentropsis ericantha F & M, *Fragm.*, ii, 140—*Sclerolaena lanicuspis* F & M, *B Fl.*, v, 1870, 195

A remarkable confusion has existed in regard to this species. Mueller (*l.c.*) described a specimen from the Darling River as *Kentropsis ericantha*. At page 170 of the same work he redescribes the species as *Anisacantha lanicuspis*, giving as type specimens the Darling River specimen, previously described as *Kentropsis ericantha*, and also a specimen from the Barrier Ranges. *Kentropsis ericantha* is placed as a synonym of *Anisacantha lanicuspis* (*Fragm.*, vii, 14) and, subsequently, this was followed in other works and by other writers. An examination of the material at present under *B lanicuspis*, however, shows that there are two distinct species present. For convenience I will term these A and B.

Species A has larger fruits and leaves than species B, is occasionally 3-, but usually 2-spined, the leaves are always densely hirsute, the fruiting perianth much hollowed at the base, and the seed obliquely, or almost horizontally, placed.

Species B has smaller fruits and leaves, is 2—4-spined, the leaves tend to lose much of their vestiture and the fruiting perianth is oblong or turbinate, with a scarcely hollowed base. The seed is vertical. The shape and base of the fruiting perianth is quite different from that of species A.

The two species resemble each other in the long silky vestiture of the flowers and fruits.

The species B is apparently the more common of the two. Mueller (*Icon Austr. Salsol.*, Plate lxxx) has apparently figured the fruiting perianths of both species. Fig. 6 represents species A and Fig. 5 appears to be species B.

On obtaining the types I found that the Darling River specimen, originally described as *Kentropsis ericantha* (*Fragm.*, ii, 140) agreed with the species A. I therefore intend taking up the specific name *ericantha*, and reconstituting the species under *Bassia*.

In regard to *Anisacantha lanicuspis*, this species was regarded by Mueller as the same species as *Kentropsis ericantha*, and he quotes the Darling River specimen as one of the types of the former species. The other type, however, from the Barrier Ranges, belongs to the species B and it was on this specimen, apparently, that Mueller drew up his description of *Anisacantha lanicuspis*.

I therefore intend maintaining the name *B lanicuspis*, but limiting it strictly to the species B.

The *Sclerolaena lanicuspis* described by Bentham (*B Fl.*, v, 195) is *B ericantha*. His description applies to this species and not to *Anisacantha lanicuspis* F & M, and he also quotes the Darling R. specimen.

Notes on B ericantha (F & M).—It is usually a small shrub or undershrub, erect, and clothed in a dense silky vestiture. The leaves are thick and up to 30 mm long. The fruiting perianth is densely hirsute, usually 2- but occasionally 3-spined, with a large hollow base. Spines up to 9 mm long. Seed obliquely placed, but inclined to the horizontal.

Range.—It occurs in Western Australia, South Australia, and New South

Wales The following localities are represented in the National Herbarium —
W.A. Cue, Nannine, N.S.W. Umberumberka, Barrier Ranges

7 BASSIA UNIFLORA (R.Br.) F.v.M.

Sclerolaena uniflora R.Br., Prodr., 1810, 410 and in B.Fl., v. 1870, 194.—
Amsacantha diacantha Nees, Pl. Preiss., 1, 635.—*Kentropsis diacantha* Moq.,
D.C., Prodr., xiii, 11, 138.—*Amsacantha kentropsidea* F.v.M., Trans. Vict. Inst.,
1855, 133. Hook. Kew Journ., viii, 204 (reduced to *A. diacantha* in Flagin., vii.,
14) — *Sclerolaena diacantha* Benth., B.Fl., v., 1870, 194 — *B. uniflora*, F.v.M.,
First Census, 1882.

A very variable species but always tomentose or hirsute. Leaves from short, thick, and obtuse, to long, linear, and almost acute and up to 30 mm. long. Spines 2, usually with a tubercle at the base of one, up to 7 mm. long, but at times reduced to very short spines or tubercles. Base of fruiting perianth much hollowed and showing radiating septa.

Hitherto the two species, *B. uniflora* (R.Br.) F.v.M. and *B. diacantha* (Nees) F.v.M., have been kept separate although both Mueller and Benthham recognised their close affinity. Benthham (B.Fl., v., 194), in a foot-note to *Sclerolaena uniflora*, suggests that *S. diacantha* may indeed prove to be a variety of *S. uniflora*. Mueller (Vict. Nat., vii, 66) states that *B. uniflora* is "only a variety of *B. diacantha*." The older name (i.e., *uniflora*), however, would have to be adopted.

In his key, Benthham separated the two species on the obtuse leaves and short spines of the one as opposed to the almost acute leaves and longer spines of the other.

An examination of the material shows that there are two extreme types, namely, one with thick obtuse leaves and very short spines (*uniflora* type), and the other with long, linear, rather acute leaves and longer spines (*diacantha* type). The former is generally found in coastal regions, whereas the latter is usually some distance inland. But it is quite impossible to separate the material along these lines. We have specimens with the thick obtuse leaves but long spines, others with the long linear leaves but very short spines, and all manner of intermediate forms. In addition, the *uniflora* type is at times found inland (Taicoola, J.M. Black). Thus we cannot separate the species either as regards length of spines, type of leaves, or locality, and for the same reason it is impossible to make a well defined variety, although the two extremes of the species look very different. Generally speaking the *uniflora* type occurs on the coast and gradually turns into the *diacantha* type as we go inland from the sea.

I have been unable to see the type specimen of *Amsacantha kentropsidea* F.v.M., which both Mueller and Benthham regarded as a synonym of *Amsacantha diacantha*, but am content to let it remain as such.

Sclerolaena diacantha var. *longispina* ? Benth. (B.Fl., v., 195)

Under this variety Benthham included two distinct species which I am describing as *B. patentiuspis* and *B. obliquiuspis* (see under *B. obliquiuspis*).

Mr. J.M. Black has drawn my attention to what appears to be a form of *B. uniflora* with a vertically placed seed. He sent over two South Australian specimens (Hergott and Arkhanga Creek) and there is, in the National Herbarium, a similar specimen from Mr. Lyndhurst. These specimens differ from typical *B. uniflora* in the position of the seed, which is vertical, whereas in typical *B. uniflora* I have always found it to be horizontal. In general appearance, the

specimens are identical with *B. uniflora* but differ slightly in the fruiting perianth and spines. The tube is longer and more constricted above the dilated hollow base than in typical *B. uniflora*, thus making room for a vertical seed. The spines are also more unequal in length. Although resembling *B. paralleliscuspa*, n. sp., in the position of the seed, the specimens are readily separable from that species by the shape of the fruiting perianth and the stouter, divaricate, unequal spines.

Although these specimens show a decided variation from typical *B. uniflora* in the position of the seed, and minor differences in the tube and spine, they appear to belong to that species and I hesitate from distinguishing them even as a variety. Additional specimens and further field observations would serve to throw light on this point.

There is also in the National Herbarium a specimen from Mt Sturt Station (A. Morris) which is distinguished from the more typical forms of *B. uniflora* (R Br) F v M by the long thick leaves which are up to 40 mm in length. The spines of the fruiting perianth are more woody than those of typical *B. uniflora*, but the specimen appears to be only a form of a very variable species.

Range—*B. uniflora* has a fairly extensive range in the drier parts of Western Australia, South Australia, Victoria and New South Wales, a large number of localities being represented in the National Herbarium. The extreme *uniflora* type is represented by specimens from St Francis Isl, Nuyt's Archipelago, Murat Bay, Tarcoola.

The specimen determined by Mueller from the Elder Exploring Expedition (Trans Roy Soc SA, xvi, 1892, 346), Victoria Desert Camp 53, is an intermediate form between the *uniflora* and *diacantha* forms.

The *diacantha* form is much the more common.

8 *BASSIA ANISACANTHOIDES* (F v M), n. comb.

Echinopsilon anisacanthoides F v M, Trans Phil Instit Viet, ii, 1858, 76 — *Anisacantha breviscapis* F v M, Fragm, n. 1863-1864, 150 — *Kentropsis breviscapis* F v M, l. c. — *Threlkeldia breviscapis* F v M, B Fl. v, 1870, 198 — *Bassia breviscapis* F v M, First Census, 1882 and Icon Austr Salsol, Plate lxvii.

While working on *B. echinopsila* F v M my attention was drawn to *Echinopsilon anisacanthoides* F v M, which was given as a synonym both by Mueller (Fragm, vii, 14) and Bentham (B Fl. v, 198). I was puzzled by the original description which would not correspond with that of *B. echinopsila* F v M, more particularly in the shape of the fruiting perianth and the position of the seed, and I came to the conclusion that Mueller had described mixed material. On this ground, I decided to reject the name *anisacanthoides*, which had prior claims, and keep to the established name of *echinopsila*.

To verify this I had the type specimen of *Echinopsilon anisacanthoides* sent from Melbourne, but on examining this found it to be a form of *B. breviscapis* F v M. The fruiting perianth of the latter species has a large hollow base, but at times the walls of this collapse or wither, or the cavity is greatly suppressed. This peculiar character of the fruiting perianth is, at times, found on the one specimen in company with the normal or typical perianth, so the distinction is not even a varietal one depending probably on the degree of maturity and the drying. Mueller has figured one instance of it in his plate of *B. breviscapis* (Icon. Austr Salsol, Pl lxvii, Fig 7, perianth on extreme left). The type specimen of *Echinopsilon anisacanthoides* F v M shows this form of fruiting perianth and therefore is synonymous with *B. breviscapis*.

As *B. brevicauspis* F.v.M. and *B. echinopsila* F.v.M. closely resemble each other in general characters other than the position of the seed and the large hollow base of the fruiting perianth, it is easy to understand how the original confusion arose.

Seeing that the species *Echinopsilon ansacanthoides* F.v.M. was described in 1858, and *Ansacantha brevicauspis* was not described by Mueller until 1863, and as the type specimen and original description are quite plain, we must take up the older name of *ansacanthoides*. I therefore propose calling the species *B. ansacanthoides* (F.v.M.), n. comb.

Bentham preferred to place the species in the genus *Threlkeldia*, but the spines and hardened perianth are quite those of a *Bassia*.

Notes in addition to the description.—A small green succulent plant, glabrous except for the flowers. Fruiting perianth 5-spined, one of which is bifid, spines 1-3 mm. long. Leaves linear, rarely more than 12 mm. long. Cavity of the fruiting perianth very large. Seed horizontal. Tube smooth and constricted near the top.

Affinity.—In general superficial appearance this species comes close to *B. echinopsila*, with which it is often confused, but the fruiting perianth is very different on close examination (*see above*). It can easily be distinguished from other species with large basal cavities by the number of spines and the shape of the tube.

Range.—The species is widely spread in Queensland and to a lesser extent in New South Wales. In the National Herbarium are specimens from the following localities.—Mt. Sturt Station, Broken Hill district, Dalby, Q'ld., Boulha, Q'ld. I have also seen specimens in the Queensland Herbarium from Roma, Dalby, Tower Hill and Wallumbilla.

9. *BASSIA TATEI* F.v.M.

Vict. Nat., vii, 1890, 66, Icon Austr. Salsol., Plate lxxi.

Notes additional to the description.—An erect perennial, the whole plant tomentose, the vestiture on the leaves being longer than on the branches. Fruiting perianth only moderately hardened, with a large swollen base, the tube marked by a few to many longitudinal ribs or furrows. Spines weak, divaricate and very irregular, 1-3 in number, the longest spine not more than 4 mm. Often with two unequal spines, the larger of which is bifid, but at times only one spine is present. The limb is fairly well developed. Leaves broad lanceolate or lanceolate, up to 23 mm. long in the specimens seen.

Affinities.—The nearest affinities are *B. diacantha* F.v.M. and *B. paralleliscuspis*, n.sp., from both of which it can be distinguished by the soft, swollen, ribbed perianth, the unequal irregular spines, and the broader leaves.

Range.—So far we have only specimens from South Australia. The specimens in the National Herbarium are from Mt. Lyndhurst and one from the Adelaide University (locality not specified).

10. *BASSIA PARALLELICUSPIS*, n.sp. (Plate xxxiv., H. J.)

Fruticulus ramosus, ramis tomentosis nonnunquam glabrescentibus, foliis hirsutis linear-clavatis sessilibus 10-25 mm. longis, floribus solitariis, perianthi fructiferi tubo tomentoso 3-4 mm. longo ad apicem, 4 mm. lato ad basin oblongam valde excavato cum limbo erecto tomentoso vel piloso 1-3 mm. longo spinis 2 parallelibus rigidis gracilibus 2-3 mm. longis usque ad medium pilosis, tertia spina minuta vel tuberculo, gemine oblique verticali.

Mt. Lyndhurst, S. Australia, 12/1897 and 8/1899.

A small under-shrub, procumbent or slightly ascending, the whole plant tomentose or hirsute. The vestiture on the older branches wears off at times. Leaves linear, sessile, the younger ones densely hirsute, the older ones sparingly so, up to 25 mm. long by about 2 mm. wide. Fruiting perianth hardened, tomentose, with a hollow oblong or oval base, the long axis of which is directed up the stem. Spines 2, generally parallel to each other and directed forwards, slender, and with a tubercle at the base of one, under 4 mm long. Tube densely tomentose, 3-4 mm long. Lamb short, erect, pilose. Seed vertical or oblique.

Affinity—This species is allied to *B. Tatei* F v M from which it can be distinguished by the much broader leaves of the former and by the nature of the fruiting perianth. In *B. Tatei* F v M the fruiting perianth is softer, larger, more irregular and the tube is much ribbed or furrowed and is only slightly tomentose, gradually becoming glabrous. The spines are divaricate and very irregular in number and size, whereas in *B. paralleliscusps* the spines are parallel, more or less equal, and regular.

The species also approaches *B. diacantha* F v M, differing in the position of the seed, the base of the fruiting perianth, the nature of the tube, and the fine parallel spines.

Range—New South Wales, South Australia and Northern Territory. Besides the locality already quoted we have specimens from the Finkle River between Crown Pt and Horseshoe Bend and Tibbooburra. The latter specimen is a smaller form than the typical one and somewhat more tomentose.

11 *BASSIA RECURVICUSPIS* W V Fitzgerald

Mueller Bot Soc, May, 1904, p. 32 — *B. litoralis* Diels, Eng Bot Jahrb, xxxv, 1905, 186.

A glabrous under-shrub, the branches striate. Leaves usually subcircular, up to 12 mm long. Tube cylindrical, hardened, hollowed at the apex, up to 4 mm long by 2 mm wide. Spines 4, recurved, two being 2-4 mm long, the other two smaller, the longer spines opposite and diverging, the two smaller approximating each other at the base. Very occasionally 5-spined.

Synonym—*B. litoralis* Diels

Although I have seen no specimens of Diels's species I am including it as a synonym owing to the close similarity between the descriptions of the two species. Diels has also furnished a figure which agrees with the type specimen of *B. recurvicusps* W V Fitz. The shape of the perianth and the character of the spines are apparently identical in both species.

Affinities—Its nearest affinity is with *B. echinopsula* F v M, from which it differs chiefly in the 4 recurved spines and the shape and base of the tube. It also resembles *B. astrocarpa* F v M in the recurved spines, but differs in the hardened perianth, glabrousness and number of spines.

Range—Apparently confined to Western Australia. The type specimens collected by W V Fitzgerald (Nannine, 9/1903) are represented in the National Herbarium. The type of *B. litoralis* Diels comes from the vicinity of Shark Bay.

12 *BASSIA GLABRA* F v M

Kentropsis glabra F v M, Fragm, 1, 139 — *Anisacantha glabra* F v M, B Fl, v., 1870, 200 — *B. glabra*, F v M, First Census, 1882, Icon. Austr. Salsol., Plate lxxv.

Notes additional to the description—A glabrous under-shrub with linear

leaves up to 11 mm long in the specimens seen. Fruiting perianth small, about 2 mm long, ribbed vertically, with 2 equal, opposite, diverging spines (often almost horizontal), usually with a stout tubercle or third small spine present. Lamb erect and hardened, forming a distinct ridge to the top of the perianth. The spines in the only specimen I have seen (Sturt's Creek, the type) are 1-2 mm. long. The seed is vertical.

I cannot altogether follow Mueller's figure (Icon. Austr. Salsol., Plate lxi) In Fig 7 he has a section of the perianth which appears to be closer to that of *B. uniflora* (R.Br.) F v M. and which shows a horizontal seed. Although Mueller placed this species in the genus *Kentropsis* which has a horizontal seed, Bentham gives the position of the seed as vertical or oblique, and the seed of the type is certainly vertical. I have not seen anything approaching Figs 1 and 6 which show the fruiting perianth with very long spines, somewhat resembling those of *B. longicuspis* F v M.

Mueller himself gives the length of the spines (Fragm., i., 139) as 1-2 lines long, and in the specimen examined I found them not to exceed 2 mm.

The species, however, is very scantily represented and additional material is necessary in order to define the species thoroughly.

Affinity.—Closely resembles *B. echinopsila* F v M in regard to the foliage, but the fruiting perianth differs in the number of spines, in general shape, and in the base. *B. echinopsila* F v M is 5-6-spined.

Range.—I have seen only one specimen (Sturt's Creek, F v M, the type).

13 *BASSIA BICUSPIS* F v M

Anisacantha bicuspis F v M. Trans. Vict. Instit., 1855, 133, Hook. Kew Journ., viii, 204, B. Fl. v., 1870, 200. *B. bicuspis*, F v M. First Census, 1882, F v M., Icon. Austr. Salsol. Plate lxxiii.

Notes in addition to the description.—Plant quite glabrous, except for the limb which is shortly tomentose or pubescent and a ring of hairs at the base of the perianth. Fruiting perianth with 2 spines up to 11 mm long and a tubercle or small spine about 1-1½ mm long. Lamb up to 5 mm long, much exceeding the length of the tube which is usually 1½-2½ mm. Branches much scarred by the falling off of the fruiting perianths and leaves.

This species is readily distinguishable from its allies by the glabrous leaves, the much greater relative length of the limb to the tube, and the spines.

Range.—The only specimen I have seen is the type (Salt Plains, Cudnaka, F v M). The other specimen mentioned by Bentham (B. Fl., v, 200) from between the Stokes Range and Cooper's Creek (Wheeler) is probably *B. longicuspis* F v M.

14 *BASSIA LONGICUSPIS* F v M

Vict. Nat., ix, 1893, 187.

Notes in addition to the description.—Glabrous except for the flowers, limb, and axils of the leaves which are more or less hirsute. Leaves succulent, often 2-3 cm long, and sometimes exceeding 4 cm, 3-4 mm in width. Spines of the fruiting perianth usually 3-4 in number, very unequal, the longest at times exceeding 35 mm; 1 or 2 spines generally much shorter than the others. Seed vertical. Stems and spines often reddish in colour.

Synonyms.—The type specimen (Charlotte Waters, Rev. Kempe, 1885) is labelled *B. bicuspis* var. *longicuspis* and underneath *B. longicuspis*. Bentham (B. Fl., v, 200) quotes a specimen from between Stokes Range and Cooper's

Creek (Wheeler) under *Amsacantha bicusps* F v M., and gives the perianth as "fully 3 lines long and the longest spine $\frac{1}{2}$ -1 inch"

This specimen quite probably belongs to *B longicusps* F.v.M. Mueller (Fragm., vii, 14) gives a var *longicusps* of *Amsacantha erinacea* with spines almost an inch long. The locality is given as Stokes Range, so the probability is that it is the same specimen as quoted by Bentham under *B bicusps*.

Affinity—Although originally placed under *B bicusps* F v M., it differs greatly from that species in the spines, shape of the tube, and the relative length of the limb and tube. Its affinity rather lies with *B tricusps* (F v M.), n comb., from which it can be distinguished by the 4 unequal spines, the scarcely distended base of the tube, and the length of the leaves and spines.

I have seen a specimen from the Queensland Herbarium, collected by Miss M J Baneroff at Longreach which appears to be a weak, less robust form of *B longicusps* F v M and intermediate between that species and *B tricusps* (F v M).

Range—The following localities are represented in the National Herbarium — S Australia Moolooloo Station between Beltana and Blinman, Mt Lyndhurst, Charlotte Waters, the type, N S W Broken Hill District, White Cliffs, and Barrier Ranges.

15 BASSIA DIVARICATA (R Br) F v M

Amsacantha divaricata R Br, Prodr, 1810, 410 — *Amsacantha erinacea* Moq, D C Prodr, xiii, ii, 1849, 122 — *Chenolea tricusps* F v M., Fragn., x, 92 (partly), but not *Amsacantha tricusps* F v M., Trans Vict Instit, 1855, 133 — *B divaricata*, F v M., First Census, 1882.

In the material labelled *Bassia divaricata* in the National Herbarium I found there were evidently 2 distinct species which for convenience may be termed A. and B.

The two can be separated by —

(1) the shape and method of attachment of the fruiting perianth. In species A the base is very oblique so that the perianth appears to be attached by its side, the tube being roughly parallel to the stem. In species B the base of the fruiting perianth is broad and swollen, the tube roughly at right angles to the stem.

(2) the limb, which is erect in B and curved over in A.

(3) the number and nature of the spines. A. has 3 unequal horizontally spreading or slightly recurved spines with usually a fourth short spine at the base of one of the others. B. has 3 somewhat ascending spines, more or less equal, without the fourth short spine of species A. Very occasionally a fourth spine is present, but it is then equal to the other 3 spines, and all placed at equal distances from one another.

(4) the position of the seed which in A is always vertical, whereas in B it is usually oblique or obliquely vertical or at times approaching the horizontal.

Species A is evidently *Amsacantha divaricata* R Br. as in the original description (Prodr, 410) Brown describes the perianth as with 4 unequal spines. I am therefore accepting species A as the true *B divaricata* (R Br) F v M.

Species B is identical with the type specimen of *Amsacantha tricusps* F.v M. (Trans Vict Instit, 1855, 133) from the Murray River.

Amsacantha erinacea Moq is evidently a synonym of *B divaricata* (R Br.) F v M., as the species is described (D C. Prodr., 13, ii., 122) with 3 spines, one of which is at times bifid. This would apply to *B. divaricata* (R.Br.) F.v.M.

Moquin was evidently somewhat confused in regard to *Anisacantha divaricata* R.Br., as he describes it (D C Prodr., 13, ii., 122, immediately preceding *A. erinacea*) as with villose leaves. Although I have not seen the type of *A. erinacea* Moq., it seems safe to assume that it is synonymous with *B. divaricata* (R.Br) F.v.M.

This leaves the way clear to take up Mueller's name of *tricuspis* for the species B., calling it *B. tricuspis* (F.v.M.), n. comb.

The differences between the two species are apparently constant, and they can readily be separated. Mueller (Icon Austr. Salsol., Plate lxxvii) has figured *B. tricuspis* (F.v.M.) together with the 4-spined form.

Notes on B. divaricata (R.Br.) F.v.M.—Glabrous except for the flowers, axils of the leaves, and the limb. Longest spine usually about 8-15 mm long, but occasionally up to 20 mm. Viewing the fruiting perianth from above, very often 1 or 2 of the spines appear to be twisted in an anti-clockwise direction.

Range—A not uncommon species in the drier parts of Western Australia. South Australia, New South Wales, and Queensland. The following localities are represented in the National Herbarium:—*W. Aust.* Gwaha, Cue, *S. Aust.* Mt Lyndhurst, Quorn, Woolshed Flat, *N.S. Wales* Broken Hill, Paroo R., Barrier Ranges, Tibookurra, Wilcannia, Warrego R., Brewarrina Downs.

16 *BASSIA TRICUSPIS* (F.v.M.), n. comb.

Anisacantha tricuspis F.v.M., Trans. Vict. Inst., 1855, 133, and in Hook. Kew Journ., viii, 204.—*Chenolea tricuspis* F.v.M., Fragm., x, 92 (partly).

I have already detailed the distinctions between this species and *B. divaricata* (R.Br.) F.v.M. under the latter species. The erect limb, the 3 more or less equal spines, and the swollen base of the fruiting perianth, with the tube at right angles to or inclined to the stem are the chief distinguishing features of the species.

The branches are glabrous and striate. The seed is usually obliquely vertical but I have seen some specimens in which it is almost horizontal.

Range—I have seen specimens from Queensland, South Australia and New South Wales, the following localities being represented in the National Herbarium:—*New South Wales*. Hay, Paroo R. District, Warrego R., (mixed with *B. divaricata*), Darling Downs (Lau?, labelled *A. erinacea* by Mueller); *Queensland* Tower Hill.

The specimen from the Suttro R. (E. Bowman) mentioned in B. Fl., v, 200 under *Anisacantha divaricata* R.Br. belongs to *B. tricuspis* (F.v.M.) It is labelled *A. erinacea*.

17 *BASSIA LANIUSPIS* F.v.M.

Anisacantha lanispis F.v.M., Fragm., ii., 170.—*B. lanispis*, F.v.M., First Census, 1862.

I have already detailed the nature of this species and its distinction from *B. ericacantha* (F.v.M.), n. comb. when dealing with the latter species.

The fruiting perianth is enveloped in long silky hairs, the tube is oblong or turbinate; spines 2-4, slender, weak, hirsute, and up to 8 mm. long or sometimes longer. The leaves have a vestiture of long silky hairs. Branches tomentose or becoming almost glabrous. Leaves usually under 15 mm. long but occasionally longer.

Range.—Occurs in Queensland, New South Wales and South Australia. The

following localities are represented in the National Herbarium—*Queensland*—Georgina R, *New South Wales* White Cliffs, Barrier Ranges, Brewarrina, Warrego R, Coolabah, Silvertown, *South Australia* Mt. Lyndhurst, Beltana.

18 *BASSIA DRUMMONDII* (Benth) F v M

Ansacantha Drummondii Benth, B Fl, v, 1870, 199.—*B Drummondii*, First Census, 1882

Under this species I include *Ansacantha hispida* Spencer Moore (Journ. Linn Soc Lon, xlv, 1920, 190) as a variety, the only difference between the two species being that one is more hispid than the other. In all other respects, both in the material and the descriptions, the two species are identical. Both are marked by the characteristic scarring of the branches by the hardened base of the leaves, and the fruiting perianths and spines are the same. The leaves and habit of the two species are also identical.

The type specimen of *Ansacantha hispida* S Moore is in the National Herbarium but no type of *Bassia Drummondii* (Benth) F v M. The Melbourne Herbarium was unable to furnish the latter, but sent a specimen of *B Drummondii*, determined by Mueller, which proved to be identical in all respects with the type of *A hispida*.

Bentham described *Ansacantha Drummondii* as with "a few long spreading hairs on the leaves."

The National Herbarium contains a specimen (Kalgoorlie, 8/1898, W V Fitzgerald) which is glabrous except for a few hairs in the axils of the leaves, flowers and limb.

In the hispid form the older leaves are very often almost or quite glabrous, the younger ones towards the ends of the branches being densely invested with long hairs. But the various forms are obviously the same species, resembling each other in the several points which characterise the species and separate it from its congeners. There is thus a species which varies from an almost glabrous form to a densely hispid form, but otherwise maintains the features which distinguish it specifically. A parallel case is that of *B quinqueospis* F v M.

We are not therefore justified in distinguishing the forms specifically and I propose to reduce *Ansacantha hispida* S Moore to *Bassia Drummondii* (Benth) F v M, var *hispida*.

Descriptive notes on the species—*B. Drummondii* may be distinguished from other members of the genus by the small obtuse leaves which, on falling off, make prominent scars on the branches. In this respect it resembles *B bicuspis* F v M but differs from that species in the nature of the fruiting perianth and spines.

The fruiting perianth is very small, the tube 1-2 mm long, and furnished with 3-4 spines, two of which are long and spreading, and up to 9 mm in length, the remaining ones much shorter or one reduced to a tubercle. The seed is usually vertical, but occasionally it is obliquely horizontal.

Var *HISPIDA*.

Distinguished from the species by the densely hispid leaves, more particularly towards the ends of the branches, but merges into the almost glabrous form of the species.

Range—The species and its variety are apparently confined to Western Australia. The following localities are represented in the National Herbarium—

Kalgoorlie (A mixture of the var *hispida* and the almost glabrous form), Mulline (the type of *A. hispida* S Moore), Kalgoorlie (var *hispida*), 12 mls E of Kanowna (var *hispida*) and between the Upper Blackwood R and Lake Lefroy (var *hispida*)

19 *BASSIA DECURRENS* J M Black.

Trans Roy. Soc S Aust, xlv, 1922, 567

A species distinguished from its allies by the pilose leaves, and the ribbed perianth tube bearing 2 divergent spines, one of which has, at or close to its base, 1-3 short spines or tubercles, which are also associated with a prominent rib of the tube. In the specimens I have examined, the tubercles or small spines are generally 1 or 2 in number and only occasionally 3. The longer spines sometimes up to 11 mm long. Its nearest affinity is *B. bicuspis* F v M., which it resembles in the short tube and the well developed limb, but differs in the pilose leaves, the tubercles or short spines at the base of the larger spine and the prominent rib to the tube. *B. bicuspis* has glabrous leaves, only one tubercle, and the tube is scarcely ribbed.

Range—So far this species is only known from South Australia and New South Wales. The following localities are represented in the National Herbarium—Port Augusta, S A (the type), Broken Hill District, Paroo River District.

20 *BASSIA OBLIQUICUSPIS*, n sp (Plate xxxiv, D-G)

Sclerolaena diacantha var *longispina* Benth, B Fl, v, 1870, 195 (in part)

Fruticulus ramosus, ramis tomentosis vel lanatis, foliis lanatis lineari-clavatis sessilibus 8-15 mm longis, floribus solitariis pilosis, stylis duobus, perianthi fructiferi tubo tomentoso subcylindrico 2-4 mm longo, cum base oblonga, leviter excavato, limbo brevissimo, spinis 2 supra medium tomentosis divergentibus oblique curvatis plus minusve aequalibus 4-8 mm longis quarum una in tuberculum decurrit, semine verticali.

Found in the western parts of New South Wales and in South Australia. N S W Barrier Ranges, Broken Hill district, Cobar, *South Australia* Black Bluff, Murray Flats, Port Augusta.

An under-shrub, the whole plant densely tomentose or lanate. Leaves linear clavate, somewhat thick, up to 15 mm long but usually shorter, and about 1-2 mm in width. The fruiting perianth has an oblong furrowed base, spreading at right angles to the tube along the stem and often equal in length to the tube. This spreading base is 2-4 mm long by 1½-2½ mm wide. The tube is up to 4 mm long. The 2 divergent spines are tomentose for about two-thirds their length, and are curved and always twisted obliquely away from each other, that is, they are not in the same vertical plane, but point in opposite directions from it. The base of one spine is always marked by a short thick tubercle.

In the past this species has been mixed up with *B. diacantha* F v M., but the two species have few points of resemblance. More particularly, the nature of the tube and the position of the seed are quite different in the two species. *B. diacantha* has a much hollowed base to the tube, and the seed is horizontal or oblique. *B. obliquispis* has only a furrow at the base of the tube, and the seed is always vertical. The ribbing and general shape of the tubes of the two species are also quite different. The oblong base extending at right angles to the tube characteristic of *B. obliquispis* is never found in *B. diacantha*.

Bentham (B Fl, v, 195) makes a var *longispina* of *B. diacantha*, but queries it. I have seen one of the specimens quoted by him, namely, Gawler's Range

(Sullivan), and this is a mixture of *B. obliquicuspis* and the closely allied species *B. patentiuspis*, n.sp. In his description of the variety he quotes the perianth as very tomentose or almost glabrous. The very tomentose perianth refers to *B. obliquicuspis* and the nearly glabrous perianth to *B. patentiuspis*.

I have refrained from taking up the name *longispina*, as both the description and the material are mixed. In addition, a similar name is already occupied by *B. longicuspis* F.v.M.

The fact that both material and description are mixed affords one legitimate grounds for not adopting the prior varietal name, which is not compulsory.

Prof. A. J. Ewart (Proc. Roy. Soc. Viet., xxvi, 1, 1914) placed the var. *longispina* under *B. lamucuspis* F.v.M., pointing out that no special varietal distinction was now necessary. The specimens, however, have little resemblance to the two species hitherto grouped under *B. lamucuspis*, differing from *B. eriacantha* (F.v.M.), n. comb. in the hollow base of the tube and the horizontal seed of that species, and from *B. lamucuspis* proper by the number of spines and the long silky hairs about the flowers and fruiting perianth of the latter species.

In addition to the localities already quoted for *B. obliquicuspis* there is a dwarf form with the tube 1-3 mm long and the spines not exceeding 3 mm., and the leaves short and densely clustered. (Broken Hill, A. Morris)

21. *BASSIA PATENTIUSPIS*, n.sp. (Plate xxxiv, A-C)

Sclerolaena diacantha var. *longispina* Benth., B.Fl., v, 195, in part

Fruticulus ramosus, ramis tomentosis nonnunquam glabrescentibus, folis pilosis linear-clavatis sessilibus 6-10 mm longis, floribus solitariis, perianthii fructiferi tubo subcylindrico parce tomentoso circ. 2 mm longo cum base ovata vel oblonga, limbo erecto 1 mm longo, spinis 2 divergentibus non oblique curvatis 3-7 mm longis quarum una in tuberculum decurrit, semine verticali.

New South Wales: Broken Hill, Barrier Ranges, *South Australia*: Baroota, Port Augusta, Beltana, *Western Australia*: Nannine.

An under-shrub closely approaching *B. obliquicuspis*, n.sp., but readily separable from that species. The chief points of difference lie in—

(1) The spines which in *B. obliquicuspis* are always twisted away from each other, apart from being divergent, so that they are not in the same vertical plane. In *B. patentiuspis* they are not twisted, but are both in the same vertical plane. This feature is constant in all the specimens examined by me.

(2) The limb which in *B. obliquicuspis* is very short, so as to be hardly noticeable, whereas in *B. patentiuspis* it is erect and well developed and approximately half the length of the tube.

(3) The shorter tube and less furrowed smaller base of *B. patentiuspis*.

(4) The vestiture. The stems of *B. patentiuspis* are not so densely tomentose and the fruiting perianth is markedly less tomentose than those of *B. obliquicuspis*. At times the tube of the former species is almost glabrous.

(5) Habit of growth. Although I have had no opportunity of studying the two species in the field myself, Miss Collins has told me that, when examining the plants in the Broken Hill district, she could readily separate them on their growth habit.

At first I intended making one a variety of the other but the differences are so constant that a specific name seems justified.

22. *BASSIA ECHINOPSILA* F.v.M.

Amsacantha echinopsila F.v.M., *Fragm.*, vii, 14 and B.Fl., v., 201.—*Chenoloe echinopsila*, *Fragm.*, x, 92.—*B. echinopsila*, First Census, 1882; *Fragm.*, xii, 12.

This species has been more or less confused with *B. amnicanthoides* (F v M), n. comb. and *B. convexula*, n.sp. Although both Mueller and Benthām placed *Echinopsilon amnicanthoides* F.v.M. as a synonym of *Anisacantha echinopsila* F.v.M., an examination of the type showed clearly that it is a form of *A. brevicauspis* F.v.M.

Notes in addition to the description in B.Fl., v., 201—An extremely variable plant in regard to its vestiture. We have a perfectly glabrous form, a form with the young shoots hirsute or pilose, and one in which all the leaves are densely covered with long hairs. Sometimes only the young leaves at the tips of the branches are slightly hirsute. The various forms merge so gradually into one another that it seems almost impossible, and of little advantage, to distinguish the hirsute form as a well-defined variety.

The tube of the fruiting perianth is oblong or cylindrical, up to 3 mm long, ribbed or furrowed longitudinally and with a grooved base with two short spurs.

The spines are usually 5, with one spine bifid, varying from 1.5 mm long, but occasionally there are 6 separate spines. They vary from almost erect to horizontally spreading, but are usually inclined upwards. The seed is truly vertical.

Affinity—In general appearance this species bears a remarkable resemblance to *B. amnicanthoides* (F v M), n. comb., and often can only be distinguished by a close examination of the fruiting perianth. In *B. amnicanthoides* the tube is hollow and the seed placed horizontally. In *B. echinopsila* the tube is not hollow and the seed is placed vertically. The shape and ribbing of the tube are also different.

Mueller's figure (Icon. Aust. Salsol., Pl. lxxix) is a very mixed one. The extreme left hand figure of the series of fruiting perianths, marked 6, is that of *B. amnicanthoides* (F v M), n. comb., Fig. 2 also appears to be the latter species. The extreme right hand one of fig. 6 is *B. convexula*, n.sp., as are also the top and lower left hand figures of series 7.

Range—This species has a fairly wide range in New South Wales and Queensland. The following localities are represented in the National Herbarium—*Queensland*: Longreach, Blackwater E. of Emerald, Rockhampton (O'Shanassy) and Crocodile Creek (Bowman). The last two specimens are quoted by Benthām (B.Fl., v., 201); *New South Wales*: Nyngan, Brewarrina, Namoi R., Cutharoo Siding, Tibbooburra, Cobar, Warrego R., Burren Junction, Mooloola Siding, Botanic Gardens, Sydney (introd.).

23. *BASSIA TUBATA*, n.sp. (Plate xxxv, A.-C)

Fruticulus, ramis erectis gracilibus tomentosis vel glabrescentibus, foliis linearibus subteretibus sessilibus 5-15 mm longis, floribus solitariis, stylis 2-3, perianthi fructiferi tubo cylindrico parce tomentoso 3-4 mm longo cum base vix dilatata excavataque, limbo erecto brevissimo, spinis 4 quarum una bifida erecta, ceteris horizontale divergentibus, 3-5 mm longis, semine verticali.

Coonamble (E. Breakwell, 1918 and R. McDiarmid, Feb. 1922).

A small under-shrub with numerous slender erect branches, the whole plant from fairly densely hirsute to almost glabrous. Leaves linear lanceolate or subterete, up to 15 mm. long by 1-1½ mm. wide. Styles usually 3, or occasionally 2. Fruit perianth more or less tomentose with a cylindrical tube, the base of which is usually somewhat dilated and hollow. Tube 3-4 mm. long by 1½-2 mm wide, the base shortly oblique, but the tube free from any lateral attachment to the stem. Spines 4, one of which is more or less erect and bifid, the remaining

three spreading more or less horizontally, all about 3-5 mm long except the smaller of the bifid spines which is 2-3 mm. Base of the perianth is usually somewhat hollowed, but at times this is not noticeable. The seed is vertical.

The only specimen of this species in the National Herbarium is one collected by Mr E Breakwell at the Coonamble Experiment Farm. I got into touch with Mr McDiarmid the manager of that Farm, and through him obtained additional specimens which showed that the specific differences were constant. He informed me that it is only to be found in places protected from stock.

The distribution of the species is peculiar, being so far found only at Coonamble. One would expect it to be found in similar localities in New South Wales.

The long cylindrical tube, free from lateral attachment to the stem and with a slightly hollow base, and the 4 spines, one being bifid and erect, the others horizontal, distinguish it from its congeners with a vertical seed. Its nearest affinity is the next species, *B. intricata*, n. sp., from which it differs in the slightly dilated and hollow base of the fruiting perianth, the arrangement of the spines, the method of attachment of the fruiting perianth, and the vestiture. *B. intricata* is glabrous except for the flowers and axils of the leaves, and the fruiting perianth is attached for the greater part of the length of the tube by the very oblique base.

24 *BASSIA INTRICATA*, n. sp. (Plate xxxv, D.-F)

Fruticulus ramosus, ramis glabris intricatis, foliis lineari-clavatis vel subteretibus sessilibus 5-15 mm longis, floribus solitariis, perianthi fructiferi tubo 3-5 mm longo sub-cylindrico cum base valde oblique, limbo erecto hirsuto 1-2 mm * longo, spinis 5, vel 4 quarum una bifida, 5-12 mm longis saepe recurvatis, semine verticali. Approximat *B. divaricatae* F. v. M.

(Corona (Miss M. Collins) Mt Lyndhurst, S.A. (Max Koch)

An intricately branched compact under-shrub, glabrous except for the hirsute flowers, limb, and for dense tufts of long hairs in and around the axils of the leaves. Leaves linear clavate or semiterete, but sometimes broader, sessile, 5-15 mm long, succulent. Flowers solitary, styles 2. Tube of the fruiting perianth cylindrical, 3-5 mm long with a very oblique base. Spines 5, or 4 with one bifid, slender, usually more or less recurved, up to 12 mm. long, but generally shorter. One spine usually much shorter than the others. Limb erect, hirsute, 1-2 mm long. Seed vertical.

This species in the past has been called both *B. quinquecuspidata* F. v. M. and *B. divaricata* (R. Br.) F. v. M., but its affinities lie with the latter species. In general habit it approaches *B. divaricata* very closely, but can be separated from that species by the number of spines (5 in *B. intricata* and 3-4 in *B. divaricata*), the erect and longer limb of *B. intricata* which in *B. divaricata* is always recurved or bent over to one side, the denser tufts of hairs in the leaf axils and on the flowers, and the more scattered fruits. The tube of the fruiting perianth of *B. intricata* is also generally longer and less tapering than that of *B. divaricata*.

While recognising the close resemblance between these two species, the differences I have enumerated are constant and appear to be specific rather than varietal.

The long tube and the limb at once distinguish the species from *B. quinquecuspidata*.

Range—In addition to the two localities already quoted there are specimens in the National Herbarium from —Milparinka, Mutooroo, S A., Lake Eyre, S A., Mt Nor West. The spines in the last-named specimen are very strongly recurved

25 *BASSIA QUINQUECUSPIS* F v M

Amsacantha quinquecusps F.v M, Trans. Vict Inst, 1855, 134 and Hook Kew Journ, viii, 204 —*A muricata* Moq, Chenop Enum, 1840, 84, and in DC Prodr, xiii (ii), 122 —*A gracilicuspis* F v M, Fragm., ii, 170 —*B quinquecusps*, First Census, 1882, Icon Aust Salsol., Pl lxxvi

This species is one of the most variable within the genus. In the typical form the plant is glabrous and intricately branched, the branches usually striate, leaves linear-lanceolate, acute, glaucous, and up to 25 mm long, but usually about 15 mm

The tube is very shortly cylindrical, 1-2 mm long, and with a very oblique base firmly attached to the stem and only broken away with difficulty. Spines 5, or 4 with one spine bifid, unequal, the longest up to 15 mm

In the var *villosa* the plant is more or less hirsute or tomentose, the vestiture on the leaves consisting of long hairs, and the branches sparingly tomentose. The fruiting perianth is also more or less tomentose. The leaves are usually broader and shorter than those of the glabrous form of the species and the spines shorter. But the differences appear to be only varietal. Some specimens are only sparingly hirsute and gradually lose their vestiture, merging into the glabrous form

The position of the seed of *B quinquecusps* is also a variable character. It may be truly vertical, oblique, or almost horizontal, but the oblique condition is most common. Generally speaking the obliquely horizontal position is most common in the var *villosa*, and the vertical position in the glabrous form. But this is not a hard and fast rule, and so cannot be taken to separate the forms specifically. The peculiar irregular character of the fruiting perianth probably accounts for the variation

I have seen the type specimen of *A gracilicuspis* F v M and it agrees with var *villosa*. Bentham placed *A gracilicuspis* as a synonym of var *villosa* and, although the name *gracilicuspis* was the first established, we must retain Bentham's name *villosa* for the variety

Vernacular name of *B quinquecusps*.—This species is widely known as Roley-poley. The older plants become detached from the ground and are driven along by the wind, gradually forming a big ball by the addition of other plants. This is finally brought up against some obstacle, chiefly fences and trees, where it piles up, forming a thick mat on decomposition.

Affinity.—This species approaches *B divaricata* (R.Br.) F.v.M., differing in the number and nature of the spines and in the shorter tube. The var *villosa* approximates closely to *B Burchii* F.v M., under which species the relationship is discussed.

Range—Probably the most common species of *Bassia* in New South Wales. It is also found in Queensland and Victoria. In the National Herbarium the typical form is represented from the following localities —Coally nr Milparinka, Tibocoburra, Burren Junction, Gunnedah, Moree, Denman, Warrego R, Bangate, Berrawina Downs, Junction bet. Murray and Darling R, Mt. Harris, Laidley

Var. *villosa* Benth is represented by the following localities —Bathurst,

Cutbaroo Siding, Forbes, Cobar, Condobolin Flats, Wanganella, Blacktown, Flemington, and Camden Municipality

26 BASSIA FORRESTIANA F v M

Chenolea Forrestiana F v M coll—*B. Forrestiana*, Fragm., xii, 1882, 12; Icon Austr Salsol, Pl lxxv

Notes in addition to the description—A fairly robust under-shrub with more or less open branches, the whole plant tomentose or hirsute. Leaves linear, recurving towards the apex and broadening slightly at the base, long, at times up to 30 mm., and 2-2½ mm in width. Tube of the fruiting perianth sub-globose or depressed, about 2-3 mm long, the limb erect and about half the length of the tube. The fruiting perianth has 2 long spines, glabrous except towards the base, and up to 25 mm long, and 1-2 or very rarely 3 much shorter spines under 7 mm long. The seed is horizontal or oblique.

I have seen only the type collected by J. Forrest at the Gascoyne River, Western Australia, in 1882. Müller's plate (Icon Austr Salsol.) gives an excellent representation of the species.

The species can be separated from its allies by the very short tube, the long spines, the dense vestiture and the somewhat thickened, apically recurved leaves.

Its nearest affinity is probably *B. limbata* J M. Black, which it resembles in the character of the leaves and the short tube. It differs from this species, however, in the much longer, more slender, spines and in the presence of the 1-3 shorter spines. *B. limbata* has only one additional very small spine and the tube is stouter.

27 BASSIA VENTRICOSA J M Black

Trans Roy Soc S A, xli, 1922, 566

A more or less hirsute under-shrub. The tube is almost globular or sub-cylindrical, hirsute, and bearing two opposite divergent spines and one or two shorter spines. In the majority of our specimens there is only one shorter spine, but two are not uncommon, and very occasionally a third one is present. The seed is horizontal or obliquely so.

It is quite a distinct species, being readily separable from its allies by the shape of the tube and the nature of the spines.

Range—The species enjoys a fairly wide range in the drier parts of New South Wales and South Australia. The following localities are represented in the National Herbarium—

N S W Barrier Ranges, Campbell's Cr Broken Hill district, Tibooburra; S. Aust Port Augusta (J M. Black 9/1920. The type) and Mt. Lyndhurst.

28 BASSIA LIMBATA J M Black.

Trans Roy Soc S A, xli, 1922, 567

This species is allied to *B. Forrestiana* F v M and *B. bicornis* (Lindl.) F v M. It seems to merge to some extent into the latter species but differs chiefly in the smaller, not so thickened perianth tube, the much more conspicuous limb which is often equal in length to the tube, and in the leaves being always tomentose or hirsute. In *B. bicornis* the leaves tend to become glabrous. The third spine on the face of the perianth is present in both species.

It is apparently confined to western New South Wales and South Australia,

the following localities being represented in the National Herbarium —Barrier Range, Mundi Mundi Plains, Broken Hill district, Campbell's Cr., Broken Hill district; we have 2 specimens (Tiboobarra, O Couch and Mt Lyndhurst, S A Max Koch), which appear to be intermediate forms between *B limbata* J. M Black and *B bicornis* (Lindl.) F.v.M

29 *BASSIA BICORNIS* (Lindl.)

Sclerolarna bicornis Lindl, Mitch Three Exped, II, 1838, 47 —*Kentropnia lanata* Moq, Chenop Enum, 83 and in D.C Prodr, xii, (II.), 138 —*Amsacantha bicornis* F.v.M, Fragn, vii, 14 —*B. bicornis*, First Census, 1882, Fragn, xii, 1882, 12, Icon Austr. Salsol, Pl lxxix

One of the more commonly known species of *Bassia* and often termed "Goat-head" It is a very variable plant, the typical form having a woolly white tomentum on the branches and fruiting perianth, but the leaves only slightly hirsute or eventually becoming glabrous At times the leaves are very long, being up to 40 mm, and 3 mm in width, but usually they are much less than this The tube is very woody, varying from 3 to almost 6 mm long, the limb erect and about 2 mm in length The fruiting perianth is 2-spined, the spines varying from 5 to 20 mm long, and often a third spine or tubercle is present on one face of the tube This third spine at times reaches 5 mm in length, but is usually much reduced

A not uncommon form of the species is an apparently stunted variety, in which the spines, fruiting perianths and leaves are all considerably reduced The spines in this form are often only 3-4 mm in length, the tube is not so much reduced, but the leaves remain more or less densely hirsute The persistent hairs on the leaves can also be found in more typical *B bicornis*

This stunted form may possibly be made a variety, but it appears to depend only on local and seasonal variations Mr J Mitchell, of Walgett, who has studied the species in the field, writes that the form is "stunted on account of the dry conditions, under ordinary seasonal conditions it is greatly increased in the size of the plant, leaf and fruit, the two colors, viz, green and white, being much more marked"

Intermediate forms between the two extreme types are also to be found

Range—This species is apparently fairly common in the drier parts of Western Australia, South Australia, New South Wales, Northern Territory, and Queensland The following localities are represented in the National Herbarium:—*Qld*: Boulia, Longreach, *N S Wales*: Nevertire, Wilcannia, Coolabah, Bourke district, Nyngan, Wanaaring to Uriseno, Bencanya, *S Aust* Lake Eyre; *W. Aust.* Barwin R., *N Terr*: Henbury Station, Finke River

The stunted form is represented by the following localities.—Walgett, Warrego R., Darling R., North-west N.S.W., Brewarrina, Namoi R.,

30 *BASSIA CORNISHIANA* F.v.M

Anstr. Chemist, 1885.

Notes on the species.—An under-shrub, the whole plant densely woolly tomentose or hirsute. The leaves are broadly lanceolate or obovate and up to 15 mm. or more long. The fruiting perianth is very broad and flat on top, 3-6 mm across, the tube short, 2-4 mm. long and tapering to a circular or ovate base Spines usually 6, rarely 5, horizontally spreading or slightly recurved, the longest rarely more than 6 mm. Commonly 5 of the spines are arranged at equal dis-

tances around the fruiting perianth, and are roughly equal in length, with a sixth smaller spine close to one of them. At times 2 of the spines are reduced in size.

Mueller (Vic Nat, vii, 47) made the species a variety of *B. Birchii* F v M, and the type is labelled by him as *B. Cornishiana*, *B. Birchii* var. I have examined the type of *B. Cornishiana* (In the vicinity of the Field River, near the boundary line between Queensland and South Australia, W H Cornish, 1885) and although it resembles *B. Birchii* F v M in the woolly tomentum, obovate leaves and robust character, it differs considerably from that species in the nature of the fruiting perianth. The fruiting perianth of *B. Cornishiana* is much larger, with a broad flat top and with 6 horizontal spines more or less evenly placed. The fruiting perianth of *B. Birchii* is much smaller, more irregular, not nearly so broad at the top, and with only 5 very irregular spines. The spines of *B. Birchii* are also much longer than those of *B. Cornishiana*.

Although, as I have previously pointed out, the type of *B. Birchii* does not absolutely agree with the specimens accepted by me as that species, yet it lies much closer to those species than to *B. Cornishiana*. In *B. Birchii* there are long unbranched shoots with the flowers more crowded towards the apex. In *B. Cornishiana* these long shoots are not so marked, and the flowers and fruits are more scattered and not so numerous.

Range—In addition to the type we have two specimens collected at Ilpilla, and also what appears to be a form of this species with longer spines up to 10 mm, and with not so broad a top to the fruiting perianth, from the upper Gascoyne R., W A.

31. *BASSIA BIRCHII* F v M

Anisacantha Birchii F v M, Fragm., viii, 163 — *B. Birchii*, First Census, 1882, Leon Austr Salsol, Pl lxxii (in part)

This is probably the most unsatisfactorily defined species of the genus. It was described by Mueller from a plant collected on the Bowen Downs, Queensland, by C W Birch. Dr Ludlow kindly sent over the type specimen and all material labelled *B. Birchii* in the Melbourne Herbarium. An examination of this material showed that there were 3 distinct species.

(1) *B. Birchii* proper which was represented by a solitary specimen, the type.

(2) *B. Cornishiana* which Mueller (Vic Nat, vii, 47) made a variety of *B. Birchii*, but which is a quite distinct species.

(3) A species which I have described as *B. convexula*, the difference from *B. Birchii* being detailed under the description of the former species.

Although the type specimen was very imperfect, yet, in regard to the fruiting perianth, the general habit, tomentum and shape of the leaves, it was apparent that it came very close to what I had regarded as a very robust form of *B. quinquecuspis* var. *villosa*.

Specimens from the Queensland Herbarium similar to this robust form were all labelled *B. Birchii*.

The Queensland and New South Wales specimens did not, however, altogether agree with the type of *B. Birchii*, differing chiefly in the length of the spines and mode of attachment of the fruiting perianth. The longest spines in the type are under 4 mm long, but in our specimens the spines are usually more than 4 mm. long and up to 15 mm long. We have, however, specimens in which the spines are much reduced.

In our specimens the fruiting perianth has a very oblique base and is very difficult to detach from the stem, whereas, in the type, the fruiting perianth has

only a slightly oblique base and is more easily detached. Some of our specimens approach this condition. Comparison, however, of the fruiting perianth is rendered difficult by the absence of mature fruits in the type. Our specimens correspond with the type in the shape of the leaves, woolly tomentum, general habit, and the number and disposition of the spines.

The type of *B. Birchii* is quite distinct from the type and other specimens of *B. Cornishiana* F v. M.

While recognising that there are slight differences between the type specimen of *B. Birchii* and the majority of our specimens I have decided to accept the latter as *B. Birchii*.

Only two other courses are open. Firstly, to place *B. Birchii* with *B. Cornishiana*, making the latter a variety, and then to describe our specimens as a new species. But the differences between *B. Birchii* and *B. Cornishiana* are too decided to place them together (See under *B. Cornishiana*). Secondly, to uphold both *B. Birchii* and *B. Cornishiana* as distinct species and, in addition, to describe our specimens approaching *B. Birchii* as a new species. But the type specimen of *B. Birchii* only varies slightly from the Queensland and our own specimens, and in addition these specimens have been collected in and around the type locality.

Should additional specimens show that the differences pointed out are constant, then, perhaps, a new species could be described.

Descriptive notes on B. Birchii F v. M.—A robust branching under-shrub, the branches often sending off long secondary branches, or intricately branched, densely clothed in a thick woolly tomentum. Leaves obovate or broadly lanceolate, up to 15 mm long and 4.5 mm wide, but usually smaller, densely hirsute. Tube of the fruiting perianth densely tomentose, very short, depressed or shortly turbinate, rarely more than 2 mm long, with usually an oblique base. Spines unequal, 5, or 4 with one spine bifid, the longest spine up to 15 mm long, but usually less. Often three of the spines are much shorter than the others, two being much reduced. Occasionally 3 of the 5 spines are long and more or less equal. The fruiting perianth is usually only detached with difficulty from the stem, tearing away with it a strip of the stem tissue. The seed is usually obliquely horizontal.

The species is commonly known as Woolly Burr, Galvanised Burr, or Roley-poley, and is a pest in certain areas, being difficult to eradicate owing to its spiny nature.

The plate of *B. Birchii* (Icon Austr. Salsol.) is a faithful reproduction of the type excepting the separate branch on the right-hand side which is *B. Cornishiana* F v. M.

Affinity—It resembles very closely a robust form of *B. quinquecuspidata* var. *villosa* Benth., differing chiefly in the thicker, more woolly tomentum, the obovate leaves, and the stouter, more robust branches and leaves. The fruiting perianth and the position of the seed of the two are very similar, but the spines of *B. Birchii* are generally rather stouter, but no longer, than those of *B. quinquecuspidata* var. *villosa*.

Although the species gives one the impression of being a very robust form of *B. quinquecuspidata* var. *villosa*, it can readily be separated from that variety and its characters are constant.

Mr Mitchell of Walgett states that the Galvanised Burr (*B. Birchii*) seldom becomes detached from the ground as is the case in the ordinary Roley-poley (*B. quinquecuspidata* and the var. *villosa*).

Mueller (Fragm., viii., 163) draws attention to the distinction between this species and *A. divaricata* var. *villosa*. There is no var. *villosa* of *A. divaricata*, so probably this was a slip, Mueller having in mind *B. quinquecuspidata* var. *villosa*.

Range—This species is becoming fairly common in New South Wales and Queensland, and is liable to be a serious pest. I have seen about 10 specimens in the Queensland Herbarium representing Queensland localities. The following localities are represented in the National Herbarium.—

Wee Waa, Gunnedah, Parkes, Narromine, Walgett, Wingham, and Jericho, Queensland

32 *BASSIA CONVEXULA*, n.sp. (Plate xxxvi, A-C)

Fruticulus sub-erectus, ramis tomentosis nonnunquam glabrescentibus cum ramulis longis erectis foliis linear-clavatis sessilibus acutis dense villosis 5-10 mm longis (nonnunquam 15 mm), floribus solitariis, perianthi fructiferi tubo tomentoso sub-globoso vel turbinato sum apice convexo ad basin vix excavatam circ 2 mm longo, limbo brevissimo, spinis 4 sub-divergentibus quarum una semper bifida (rarissime 5), spinis bifidis 1-1½ mm longis, ceteris 2-4 mm longis infra medium tomentosis, semine horizontali

A more or less erect under-shrub, the branches sending up long shoots up to 25 cm long, the whole plant tomentose or villosa, or the older branches in time becoming almost glabrous. Styles 2. Leaves linear-clavate, acute, and usually 5-10 mm long, but sometimes longer.

The tube of the fruiting perianth is sub-globose or almost ovate-truncate, convex at its apex, tomentose, and slightly, or not at all, ribbed. Lamb short. Fruiting perianth with usually 4 somewhat ascending spines, one of which is always bifid, the bifid spines being much shorter than the others. Base of the tube slightly concave and somewhat circular in outline.

A very distinct species which, in the past, has been confused with various species, principally *B. quinquecuspidata* F v M., *B. echinopsila* F v M., and *B. Birchii* F v M.

Although quite distinct from *B. echinopsila*, it has been most commonly confused with that species.

It can be readily separated from *B. echinopsila* by the dense tomentose vestiture of the fruiting perianth, the number of spines, the shape of the tube and the horizontal seed, the two species having very little in common.

Mueller, most probably, originated the mistake as he has figured both species in his plate of *B. echinopsila* (Leon Aust Salsol., Plate lxi.). The extreme right-hand figure of series 6, and the top and lower left-hand figures of series 7 are all *B. convexula*. The differences between the fruiting perianths can at once be seen from the figures.

In addition there is in the National Herbarium a specimen from the Warrego River (E. Bêche), labelled by Mr Bêche as having been determined by Mueller as *B. echinopsila*, the greater part of which is *B. convexula*, with a small fragment of *B. echinopsila*.

Mueller and others have also confused it with *B. Birchii* F v M. In the Report on the Elder Exploring Expedition (Trans. Roy. Soc. S.A., xvi., 1892, 346) Mueller refers to a "remarkably dwarf form, although copiously fruiting" of *B. Birchii*. This specimen is *B. convexula*. Although not altogether satisfied as to the true nature of *B. Birchii*, I am quite satisfied that it cannot be referred to this species. I have seen the type of *B. Birchii* and it is a much more robust plant, with a thicker, more woolly tomentum and broader leaves, which cannot be confounded with those of *B. convexula*. The shape of the fruiting perianth and the nature of the spines are also different.

B. convexula is readily separable from *B. quinquecuspidata* F.v.M. by its easily detached, regularly-shaped fruits, the dense tomentum, the shape of the tube and the more erect, less intricately branched habit of the plant.

Range—The species is widely distributed in the drier parts of Western Australia, South Australia, and New South Wales. The following localities are represented in the National Herbarium—Girilambone, Poppy Mt. nr. Cobar, Coolabah, Broken Hill, Warrego R., Cobar, Paroo R. In addition I have seen some South Australian specimens sent over by Mr J. M. Black. The only Western Australian locality I have seen is that recorded by the Elder Exploring Expedition, already quoted.

33. *BASSIA PARVIFLORA*, n.sp. (Plate xxxvi., H-L.)

Fruticulus sub-erectus, ramis gracilibus parce hirsutis, foliis lineari-clavatis sessilibus 4-8 mm longis (rarissime 12 mm) parce hirsutis, floribus solitariis, perianthi fructiferi tubo plus minusve hirsutis subdepresso vel turbinato 1-1½ mm longo cum limbo brevissimo, spinis 6, vel 5 quarum una semper bifida, 1-2½ mm longis, semine horizontali. Approximat *B. convexula*.

A small, slender, twiggy plant with intricate branches. Leaves linear-clavate, small and scattered, rarely exceeding 8 mm long. Flowers solitary in the axils of the leaves. Styles 2. Tube small, depressed or broad turbinate, flat on top, 1-2 mm. long and bearing 6 small spines, or 5 with one spine bifid. Spines spreading horizontally or slightly inclined to the vertical. The leaves, branches, and fruits are more or less covered with a vestiture of long, somewhat thickened, translucent hairs.

This species approaches closely to *B. convexula* but differs in

(1) The fruiting perianth, it has not the domed apex so typical in *B. convexula*, and the spines spread more horizontally and are always one more in number than those of *B. convexula*. Very occasionally *B. parviflora* has 6 spines, or 5 with one bifid, but then it is only in isolated instances in the one specimen.

(2) The general habit, which is more twiggy than that of *B. convexula*, and in the smaller, more scattered leaves and fruits. The plant is weaker and not so robust.

(3) Nature of the vestiture. In *B. convexula* the vestiture, particularly on the branches, consists of a fine cottony tomentum, that is to say, the individual hairs are weak, fine, whitish, and fairly short. The hairs of *B. parviflora* are of quite a different character, being longer, much stouter, straight, and translucent. The difference in the vestiture is quite apparent when examined through a lens, and I have always found the differences to be constant.

Three of the four specimens I have placed under this species were labelled *B. echinopsila*, but the species bears no relation to *B. echinopsila*, differing in the vestiture, shape of the fruiting perianth and the position of the seed.

Range.—The four specimens I have placed under this species are from widely scattered localities in Victoria, South Australia and Western Australia. They are:—Mildura, Vic., Victoria Springs, Minnips, S.A., and Doodlakine, W.A.

34. *BASSIA COSTATA*, n.sp. (Plate xxxvi., D-G.)

Fruticulus sub-erectus, ramis parce tomentosis, foliis hirsutis lineari-subclavatis sessilibus 6-10 mm longis, floribus solitariis, perianthi fructiferi tubo subcylindrico parce hirsuto demum glabrescente 1½-2 mm. longo, 1½ mm lato ad apicem planum et 1 mm. lato ad basin annulatam vix excavato, cum costa prominente ad spinam bifidam adscendente, limbo brevissimo, spinis 4, 2-4 mm. longis, quarum una semper

bifida, horizontalibus vel leviter recurvatis, semine horizontali. Approximat *B. convexulae*.

60 miles NE of Camp 12, Northern Territory (G. F. Hill, 6/1911). Quoted as *B. echinopsila* by Ewart and Davies (Flora of the Northern Territory, 1917, p. 95), Glen Ferdinand, Musgrave Ranges (S. A. White, 7/1914).

A small erect plant, the branches sparingly tomentose, the leaves densely lustrate. Leaves linear, slightly clavate, acute, 6-10 mm long.

The fruiting perianth is slightly hairy, but becoming almost or quite glabrous, flat on top, and is furnished with 4 spines, one of which is always deeply and regularly bifid forming two spines somewhat smaller than the other 3 spines. The two short bifid spines are united at their base to form a short, flat, broad projection of the fruiting perianth marked on the under surface by a prominent rib which continues down the tube. The remainder of the tube is slightly ribbed or striate. The spines spread horizontally or are slightly recurved, the longer ones up to 4 mm long. The tube narrows towards the circular, slightly hollowed base. Styles 2. Seed horizontal.

This species is allied to *B. convexula*, but differs from that species in the glabrous, or almost glabrous fruiting perianth, in the flat top of the tube, in the more prominent ribbing of the tube beneath the bifid spines, and in the stouter horizontally spreading spines. The fruiting perianth of *B. convexula* is domed, tomentose, and the spines are more acicular and ascending.

35. *BASSIA MICROCARPA*, n. sp. (Plate xxxvi, M-Q)

Fruticulus ramosus, ramulis longis gracilibus pilosis, foliis sessilibus linearibus acutis 6-10 mm longis dense pilosis floribus solitariis, perianthi fructiferi tubo depressus-cylindrico costato $\frac{1}{2}$ mm longo circ. 1 mm lato glabro cum limbo brevissimo, spinis 5 quarum una semper bifida horizontalibus ad apicem valde recurvatis circ. $\frac{1}{2}$ mm longis, semine horizontali.

Poison Creek via Leonora, W. Aust. (A. McGregor, 9/1909), the type.

A very distinct species, easily separated from other members of the genus by the long, soft, dense hairs on the leaves and the numerous very small fruits. Styles 2, connate at the base. The tube of the fruiting perianth is very shortly cylindrical, under 1 mm long and 1-1 $\frac{1}{2}$ mm in width, glabrous, and ribbed vertically, slightly hollow at the base and marked by 5 distinct perforations. Spines 5, one of which is bifid, equal and placed at regular intervals around the fruiting perianth, about $\frac{1}{2}$ mm long, spreading horizontally, but sharply hooked at the ends, the tips often being much darker in colour. At times the spines appear to be united by a very narrow rim or expansion of the fruiting perianth, showing an affinity with the *Maireana* section.

I have seen only the one specimen. At first I believed that this plant might be *B. macranthera* (Benth.) F. v. M. The type of this species was Drummond's n. 253, Fourth Coll. (W. A.), and Mueller (Fragm. vii, 12) refers it with doubt to *Kochia villosa*.

Bentham (B. Fl., v, 181) describes it as *Enchylaena* ? *macranthera*, making reference to Mueller's opinion, but stating that he can see no trace of any wing or transverse prominence to the perianth. He also describes the perianth as "already much enlarged after flowering with the fruit nearly ripe, globular, glabrous or hairy especially the lobes, smooth and rather thick scarcely $\frac{1}{2}$ line diameter, lobes 5 short, obtuse, connivent over the fruit." He can find no trace of appendages, and accordingly will not allow it to remain under *Kochia*, but transfers it provisionally to *Enchylaena*.

This description does not agree in any sense with the perianth of *B. microcarpa* which is furnished with 5 or 6 distinct spines which are quite apparent even in the flowering stage. Although Mueller later transferred *Enchylaena micranthera* to the genus *Bassia*, it does not follow that he observed spines on the fruiting perianth, as he included several non-spined species in that genus, e.g., *B. enchylaenoides* and *B. carnosa*.

I obtained the type specimen of *B. micranthera* from the Melbourne Herbarium, but this had no flowers or fruits. A specimen from Aithorpe, S.A. (Dr R. S. Rogers, 9/1907) matched the type very closely, but this also had neither flowers or fruits. The vestiture of the type and that of *B. microcarpa* are practically identical, but this is not a strong point, as the vestiture is also identical with that of *B. brachyptera* (F v M).

As Bentham's description of the perianth of *E. micranthera* is so clear and leaves no room for doubt, I could not refer the specimen of *B. microcarpa* to it, although both agree in the nature of the vestiture and the smallness of the fruits. Two minor differences between *B. microcarpa* and *B. micranthera* lie in the number of the styles and the general habit of the plant. Bentham gives the number of styles of *E. micranthera* as 3, whereas in *B. microcarpa* I have only found 2. The secondary branches of *B. microcarpa* are apparently much longer and more slender than those of *B. micranthera*. Owing to the nature of the perianth and the absence of spines in *B. micranthera* (Benth.) F v M, this species cannot be retained in the genus *Bassia*, and perhaps is best placed under *Enchylaena* where Bentham originally placed it. The flowers and ripe fruits of the species, however, are necessary to determine its position satisfactorily.

36. *BASSIA BIFLORA* (R.Br.) F v M

Sclerulaena biflora R Br, Prodr, 410 — *Dissocarpus biflorus* F v M. Trans Phil Inst. Viet, ii, 75 — *B. biflora*, Fragm, xii, 1882, 12, Icon Austr Salsol, Pl. iii

A procumbent shrub clothed in a white woolly vestiture. Leaves linear, acute, up to 20 mm long, but usually 8-15 mm. The connate fruiting perianths are usually without spines, but occasionally short spines or tubercles are present. In a specimen from Mt. Start Station, Broken Hill District (A. Morris) there are 1-3 well developed spines, 1-2 mm long. These are usually 2 in number, one being on either side of the connate perianths.

The spiny form varies slightly in the nature of the fruiting perianths. These, in the typical non-spined form, are horizontally divergent from the common base, but in the spined form one is almost vertical or inclined upwards, the other diverging horizontally.

Range — In addition to the specimen already quoted the following localities are represented in the National Herbarium — Murray R, Lachlan R, Barrier Range, Mt. Lyndhurst, S.A.

Var. CEPHALOCARPUM F v M (Fragm, viii, 36).

Fruiting perianths 3-7 in the head. The vestiture of the variety is usually not so dense as that of the typical species, but no sharp line of demarcation is possible between the variety and the species. For example 2-flowered and 3-flowered heads may be present on the one plant.

The variety is readily distinguished from *B. paradoxa* (R.Br.) F v M. by the almost complete absence of spines.

The following localities represent the variety in the National Herbarium:—
Bourke Dist., Brewarrina, and Mooculta Siding

37 *BASSIA PARADOXA* (R Br) F v M

Sclerolaena paradoxa R Br, Prodr, 1810, 410 — *Chenolea paradoxa* F.v.M., Fragm, x, 91 — *B. paradoxa*, First Census, 1882, J Hook, Icon Pl, 1076, F v M, Icon Austral Salsol, Pl lxii

Notes additional to the description—A decumbent shrub densely clothed in a loose tomentum. The fruiting perianths are connate into a hard mass of 8-16 individuals, the whole measuring up to 15 mm. or more in diameter. J M Black (Trans Roy Soc SA, 1916, 459) found the number of connate fruits in the head to be 8, each being 2-5-spined. On dissecting the heads, I have found as many as 16 fruits.

As far as I have observed in the specimens in the National Herbarium, the heads are always spiny, the spines being up to 5 mm long, but usually shorter. The leaves are thick, and up to 15-20 mm. long by about 3 mm in width, but usually smaller. The seed is placed horizontally.

Var *LATIFOLIA* J M Black (Trans Roy Soc SA, xlii, 1922, 567)

This variety is distinguished by the much broader leaves (5-8 mm in width), and by the spines being reduced to 5 short obtuse and rather soft horns. From the limited number of available specimens, Mr Black is unable to say whether this characteristic of the fruit appendages is constant.

Mueller (Fragm, vii, 11) pointed out that the leaves of *B. paradoxa* were sometimes 3 lines (about 6 mm) in width, so probably he had in mind this variety.

Range—This species enjoys a fairly wide range in the drier parts of Queensland, New South Wales, Victoria, South Australia, and Western Australia.

38 *BASSIA SPINOSA* Ewart and Davies

Fl N Terr. 1917, p 95, Pl xii

I have seen no specimens of this species but, judging by the description and plate, it is a distinct species, approaching *B. paradoxa* (R Br) F v M., but differing from that species in the fewer flowers in the head and in the stronger, divided spines.

39 *BASSIA TRIDENS* F v M

Fragm xii, 1882, 12, Icon Austr Salsol., 1889, Pl. lxiv

A branching under-shrub, at first very slightly hirsute, but soon becoming glabrous, except the axils of the leaves, base of the fruiting perianth, and the flowers. Leaves linear, semi-terete, 5-12 mm. long, tube of the fruiting perianth very shortly cylindrical, somewhat dilated towards the much or slightly hollow base, 1-2 mm long. Fruit perianth flat on top, with 3 horizontally spreading, broad, flattened appendages, one of which is bifid. These appendages resemble much flattened spines and, at their base, are 2-2½ mm. across, but taper to a sharp point. Each flattened appendage is about 5-6 mm long, much hardened, and on the under surface is marked by a longitudinal rib which continues down the perianth tube. The seed is horizontal.

This species is quite distinct from other members of the genus by reason of the broad flattened appendages, which may be taken to represent flattened spines. It certainly deserves a sectional, if not a generic, distinction.

Sectionally it comes nearest the *Maureana* Section, but differs in the regular, well defined spines and the absence of the horizontal wing expansion

The only specimen I have seen is the type, Gascoyne R (J Forrest)

40 *BASSIA LUEHMANNI* F v M

Icon Austr. Salsol, 1889, Pl. lxx.; Viet Nat., vii, 1890, 47 and Bot. Centralb., xlii, 1890, 371

A rather dwarf under-shrub, more or less densely hirsute, or the leaves sparingly so. Leaves rhomboid in the upper part and narrowing into a fairly long petiole-like base. The tube of the fruiting perianth is almost flattened, very short, being barely $\frac{1}{2}$ mm long, and is furnished with a wide hardened expansion broken up very irregularly into spines or spine-like segments which often are, in turn, again broken up or bifid. The fruiting perianths are densely clustered along the branches and are sparingly hirsute. Seed horizontal.

This species is readily separated from all other *Bassias* by the very short tube, the broad expansion broken up into spines, and the peculiar leaves which are found in this species alone. The broken expansion shows an affinity with *B. stelligera* F v M, but the insignificant tube is very different.

The only specimen I have seen is the type, Finke R (Rev W T Schwaiz, 1886)

41 *BASSIA STELLIGERA* F v M

Maureana stelligera F v M, Fragm., i, 139.—*Echinopsilon stelligerus*, Fragm., vii, 13.—*Kochia stelligera* F v M, Fragm., vii, 13 (inferred) and B Fl., v, 189.—*B. stelligera*, F v M, MS Third Census; Icon Austr. Salsol., Pl. lxxviii.

Notes additional to the description.—A procumbent under-shrub clothed in a dense, woolly, white tomentum, but the stems at times tending to become glabrous. Tube of the fruiting perianth globose, usually smooth and with a thin horizontal expansion which is broken up into spines. These spines are sometimes 15 in number, but usually about 8-12, often bifid or with secondary spines, and about 1 mm. long. The unbroken section of the expansion is $\frac{1}{2}$ -1 mm. or even more in width. At times the expansion is only partially broken up, the spines being represented by irregular denticulations, marked by ribs on the under side. The leaves are up to 20 mm long, but usually are much shorter.

This species, together with the other members of the section, shows the transition from the genus *Bassia* to the genus *Kochia*.

The following localities are represented in the National Herbarium—Victoria Gannawarra, N S W. Berrawina Downs, Newire, Namoi R., Wanganella, Cobar, Warrakoo, Coonamble.

42 *BASSIA BRACHYPTERA* (F v M.), n comb.

Kochia brachyptera, Sec Gen Rep, 1854, 15, Icon Austr. Salsol, Pl. lx—*Sclerochlamys brachyptera* F v M, Trans Phil Inst. Vict., ii, 76—*Echinopsilon brachyptera*, Fragm., vii., 13

Mueller (Fragm., xii., 15) pointed out that this species and *Kochia stelligera* F v M merged into the genus *Bassia*. In his MS. of the Third Census he placed *Kochia stelligera* under *Bassia* and also figured it under that genus in Icon Austr. Salsol, but he preferred to allow *Kochia brachyptera* to remain under *Kochia*. Its affinities, however, lie with *Bassia* rather than with *Kochia*, although, like

other members of the *Maureana* Section, it is really a transition form between the two genera. The fruiting perianth is much hardened, like a *Bassia*, and the expansion is hardened and marked by 5 very short spines.

Mueller (Viet. Nat., vii, 1891, 66) suggested that the three species, *K. brachyptera*, *K. stelligera*, and *K. ciliata* be excluded from both *Kochia* and *Bassia*, forming a separate generic group. For this he proposed the name *Sclerochlamys*, but added that the three species might be retained under *Bassia* if a wider definition were given to that genus. *Kochia ciliata*, however, undoubtedly belongs to the genus *Kochia* as the membranous expansion is quite decided.

Notes on B. brachyptera (F. v. M.), n. comb.—Leaves and branches densely invested with long hairs, the older branches at times almost glabrous. Leaves usually 10-15 mm long. The fruiting perianth is glabrous, the tube short, about 1½ mm long and tapering to a circular base with 5 small perforations. The tube is usually marked by 10 longitudinal ribs, 5 of which are produced into short recurved spines, united by the hardened expansion. The fruiting perianth is 2½-4 mm in diameter at the top, including the expansion, the flat top being marked by 5 radiating ribs running out into the spines. The very short spines appear to be a prolongation of the ribbing of the tube, or as acute somewhat produced corners to the flat top of the fruiting perianth.

The presence of the spines although much reduced and not typical of the genus, and the hard nature of the expansion indicate its closer affinity with the genus *Bassia*. Specifically its nearest ally is *B. microcarpa*, n. sp., a species which undoubtedly is a *Bassia*. I have placed it in the section *Maureana* because of the expansion of the fruiting perianth, but the nature of the spines and ribbing is quite different from the other members of that section. Altogether, it is a difficult species to place satisfactorily.

Range—N. S. Wales. Wilcannia, Yandama, Brewarrina, Condobohn, Warrego R., Bourke, Darling R., Mt. Browne, Vic. Lake Hindmarsh, Murray R., S. Aust. Patawurta, Flinders Range, Moolooloo Station between Beltana and Blinman, Mt. Lindhurst, Edinowie.

Species excluded from the genus Bassia, or imperfectly known

Bassia longifolia W. V. Fitzgerald, Muell. Bot. Soc., 1904, 32

We have the type specimens of this species (Nannine, W. A., Sept., 1903) and they are identical with *Kochia fimbriolata* F. v. M. The latter was described in *Fragm.* ix, 75, and a plate is given in *Icon. Austr. Salsol.*, both description and figure agreeing in every particular with the type specimen of *Bassia longifolia* W. V. Fitz. The short hardened tube with the 5, scarcely membranous or somewhat hardened, horizontal wings, the 5 erect appendages, and the long bristly leaves are the chief features of the species.

Fitzgerald, in his description of *B. longifolia*, remarks that it approaches *K. fimbriolata*, but does not point out wherein it differs, and the possibility is that some confusion existed as to the true nature of the latter species. The possession of a hardened tube, although not very common in the genus *Kochia*, does not exclude a species from that genus, and the 5 wings are a characteristic generic feature.

Bassia longifolia W. V. Fitz. must, therefore, be reduced to a synonym of *Kochia fimbriolata* F. v. M.

Bassia carnos (Moq.) F.v.M., First Census, 1892

Echinopsylon ? *carnosus* Moq, DC Prod, xii. (n.), 196.—*Trichemum carnosum* Moq in herb Hook.—*Chenolea carnos* Benth, B.Fl., v, 1870, 190 — *Bassia lanuginosa* C. T. White, Q'ld. Agric. Journ, xv, 1921, 216

O. Paulsen (Dansk. Botanisk Arkiv, ii (8), 1918, 58) points out that, as the perianth of this species is wingless and spineless, the species must be included under *Chenolea*. I have examined the fruiting perianths of this species which are concealed under dense white wool, and have always found them to be furnished with a definite horizontal wing or expansion. This wing is continuous, semi-membranous and transparent, or thickened and opaque, and is usually about 1 mm or occasionally more in width. The fruiting perianth is hardened.

The species, therefore, must be placed in the genus *Koochia*, as it has the two main characteristics of that genus, namely, wing expansion and altered perianth. The fruiting perianth of *Chenolea*, on the other hand, is unaltered, and free from any appendages or wing expansion. I, therefore, propose the name *Koochia carnos* (Moq.), n. comb., for the species.

Synonym.—*Bassia lanuginosa* C. T. White.

Through the Director, Mr. Maiden, I have corresponded with Mr. White and he agrees that this species is synonymous with *Koochia carnos* (Moq.), n. comb.

The nature of the fruiting perianth, the vestiture of the leaves and fruits, and the peculiar arrangement of the floral leaves are identical in the two species.

The distribution of the two species is certainly peculiar. *Koochia carnos* is a Western Australian species, whereas Mr. White's specimen comes from the Mayne R., Queensland. As it is apparently an isolated patch, it may possibly have been introduced, but in all events geographical separation is not sufficient ground for specific distinction.

The only differences between the Queensland specimens and the Western Australian species appear to be the slightly greater size of the leaves of the former, a slightly greater development of the wool about the fruiting perianth, and the flowers and fruits being in a looser arrangement. On these points the Queensland specimens, especially if added to by similar specimens from other localities, may possibly be distinguished as a variety.

Bassia hostilis Diels, Engl Bot Jahrb, xxxv, 1904, 185

I have seen no specimens of this species and no figure is given with the description, and I therefore hesitate to express a definite opinion of the species. But on the description alone, I am unable to separate it from *Bassia divaricata* (R.Br.) F.v.M., the features of both species apparently agreeing in every particular. Diels quotes *B. hostilis* as "approaching *B. divaricata* in some respects, e.g., dioecious flowers and spines united at the base," but omits to enumerate the points of difference. Being therefore imperfectly known to me, I was unable to include the species in the revision.

Bassia suadacea F.v.M., Vict. Nat., vii., 1890, 42 (*nomen nudum*.)

The name appears in the minutes as that of a species included in a paper read by Luehmann on behalf of Mueller, but neither the name nor description is included in the paper, so apparently it was suppressed by Mueller. I can find no further trace of it.

Kentropus cornuta F v M, Sec Gen. Report, 1854, 15

Other species included in the genus *Kentropus* were later transferred to *Bassia*. The above species, however, appears as a *nomen nudum* in the Sec. Gen. Report, and I can find no subsequent reference to it.

Sclerolaena coriacea Moq in DC, 13 (11), 123

Bentham (B Fl, v, 1870, 194) remarks that this species is unknown to him and, the perianth being devoid of spines, may not be a true congener. I have found no further reference to the species.

Bassia enchylaenoides F v M and *Bassia tricornis* (Benth) F v M

Owing to the character of the fruiting perianth of these two species, they must be excluded from the genus, and apparently do not come within the limits of the allied genera. I intend dealing with them separately in a subsequent paper.

Bassia mucranthera (Benth) F v M

I have dealt with this species under *B. microcarpa*, n.sp.

EXPLANATION OF PLATES XXXIV-XXXVI

Plate xxxiv

Bassia patentiuspis, n.sp.

A Branch B Fruiting perianth C Vertical section of fruiting perianth showing position of seed

Barrier Ranges Miss M I Collins, No 16, Aug, 1921

Bassia obliquouspis, n.sp.

D Branch E Top view of fruiting perianth. F Basal and lateral view of fruiting perianth G Vertical section of fruiting perianth showing position of seed

Port Augusta, SA J M Black, Sept, 1920

Bassia parallelouspis, n.sp.

H Branch I Side view of fruiting perianth K Basal view of fruiting perianth L Vertical section of fruiting perianth showing position of seed.

Mt Lyndhurst, SA Max Koch, Sept, 1899

Plate xxxv

Bassia tubata, n.sp.

A Portion of plant B Fruiting perianth C Vertical section of fruiting perianth showing position of seed

Coonamble E Breakwell, 1918

Bassia intricata, n.sp.

D Branch E Fruiting perianths in situ on the stem F. Vertical section of the fruiting perianth showing position of the seed

Mutooroo, SA A Morris, No 635, Aug, 1921

Plate xxxvi

Bassia convexula, n.sp.

A Branch B Fruiting perianth C Section of the fruiting perianth showing position of the seed

Cobar L Abrahams, Aug, 1911

Bassia costata, n. sp.

D. Portion of plant E, F Side and top view of fruiting perianth G Vertical section of the fruiting perianth showing position of the seed
 Sixty miles NE C2 N Territory G F Hill, June, 1911

Bassia parviflora, n. sp.

H Branch I, K Side and top view of fruiting perianth L Vertical section of fruiting perianth showing position of the seed
 Minnipa, SA J M Black, Nov, 1915.

Bassia macrocarpa, n. sp.

M Portion of plant N Side view of fruiting perianth O Top view of fruiting perianth P Bottom view of fruiting perianth Q Section of fruiting perianth showing position of the seed
 Poison Creek, via Leonora, W A A A McGregor, Sept, 1909

STUDIES IN PLANT PIGMENTS

PART I—THE YELLOW COLOURING MATTER OF THE ACACIAS

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(From the Physiological Laboratory of the University of Sydney)

(Five Text-figures)

[Read 29th August, 1923]

Introduction

Our knowledge of plant colours has been traced back to the old civilisations of Persia and India. It is closely associated with the art of dyeing as practised by these ancient nations.

Though from nearly every plant may be extracted some potential colour substance which, if combined with certain chemical salts, will produce a dye, there are very few plants found to contain an actual dye-stuff. The latter may be exemplified by indigo blue, the brown stain of walnut fruits, and the yellow and brown pigments contained in some lichens.

The pigments, so widely distributed in the vegetable kingdom, are found however in greater concentration in certain specific plants. Some of these contain *yellow* colour substances which have been used for centuries, such as alkanet of the Romans, turmeric of India and China, weld used by the Gauls before their conquest by Caesar, safflower of the Egyptians, fustic, and quercitron.

Our chemical knowledge of these yellow plant pigments begins with the study of quercetin by Herzig in 1884, and recent research has disclosed the fact that many of them belong to the flavone group of organic compounds, indeed, as Perkin has said, of all the natural dyes these yellow flavone pigments are the most widely distributed in nature.

Plant pigments are considered biochemically in two distinct groups—the plastid pigments and the water-soluble pigments. In the former the molecule of the colour substance is combined in some obscure chemical way with the other components of the complex colloidal molecule of protoplasm, in this group chlorophyll, carotin, and xanthophyll are well known. Of the water-soluble pigments found in solution in the cell-sap, the yellow coloured substances are mostly flavone and xanthone pigments, while the blue, red and purple colours of flowers are called anthocyanins.

EXPERIMENTAL

- I *Acacia discolor*.
- II *Acacia limifolia*
- III *Acacia decurrens*, var *molle*
- IV *Acacia longifolia*

The *Acacias* afford us the best available material for the study of the yellow pigments of plants. They constitute, with the *Eucalypts*, a large part of the unique flora of Australia, more than 300 endemic species are distributed throughout the continent, and in all seasons of the year one or more is to be seen in flower. The beautiful fluorescent masses consist largely of dense crowds of stamens, petaloid and unprotected, and their colour ranges from palest cream to deepest golden yellow.

Hitherto nothing was known of the chemical nature of these golden wattle-blossoms, or of the substances to which they owed their beauty. In this investigation the yellow pigments have been extracted, and their properties studied.

The Material—Four typical examples of *Acacias* were chosen for this investigation: two of these possess the characteristic pinnate mimosa leaves, and two have their leaves replaced by phyllodes in response to their xerophytic environment. The flowers were collected in quantity at the period of maximum inflorescence, in the neighbourhood of Sydney and the Blue Mountains.

General Method of Extraction—As soon as possible after collecting, the fresh flowers were immersed in small amounts at a time in boiling water, in order to destroy the enzymes. The boiling was continued for some hours, after which the material was pressed, and again extracted until most of the soluble colouring matter was removed. The large volume of fluid was evaporated to about 2 litres, after which the proteins were coagulated with acetic acid and removed.

The aqueous fluid was then precipitated by normal and basic lead acetate, the precipitates contained the colouring matter and tannins. The lead was removed, and the pigments were hydrolysed by boiling with dilute sulphuric acid, during which operation the glucosides were decomposed into yellow pigment and sugars. The pigment was next extracted by agitation with ether, and the remaining aqueous fluid was reserved for the sugar. On distilling the ethereal extract the colouring matter was obtained in the crude state, and was then purified by a series of fractional crystallisations.

I *Acacia discolor*.

The flowers of *A. discolor*, the sunshine wattle, were collected at Sutherland and Hornsby in the month of April.

Extraction of the Soluble Yellow Pigment—Hot aqueous extracts were made, which after concentration were agitated with ether. The absence of yellow pigment from this ethereal extract showed that no free flavone existed in the plant, and that the pigment was present wholly in the form of a glucoside. The latter was precipitated by lead acetate, and after removal of the lead from the precipitate, it was submitted to acid hydrolysis. This operation resulted in the formation of (1) a black resinous substance which was insoluble in the hot fluid, (2) a deep brick-red deposit which formed on cooling, and was removed by decantation, (3) a bright red-coloured solution.

The second and third of these were completely extracted with ether, which gave a deep yellow solution of the pigment. The last few extractions were brown coloured and yielded on evaporation no yellow pigment, but a pale brown amorphous substance which possessed an astringent taste and gave the reactions of a tannin.

The filtrate from the lead acetate precipitate obtained above was treated with basic lead acetate, when a further precipitation occurred. The lemon-yellow coloured deposit was hydrolysed in the same manner as the former and yielded a bright yellow ethereal solution.

These ethereal extracts were concentrated and then agitated with successive small amounts of ammonium and sodium carbonates. The yellow colouring matter passed into both alkaline solutions from which it was reprecipitated by pouring into acid.

The ammonium carbonate extract at first was green in colour, in half a minute it became red, and soon changed to purple and violet. These coloured solutions gave the reactions of anthocyanins. The yellow precipitates obtained from the acid solutions consisted of crude colouring matter.

Purification of the crude yellow pigment—The yellow crystalline deposits contained a red colouring matter and an amorphous brown substance intermixed. By dissolving in hot alcohol a deep red solution resulted, and on carefully diluting this with hot water a point was reached when the yellow pigment could be crystallised out alone. When recrystallised in this way a number of times, the filtrate at last ceased to be red, and a mass of lemon-yellow, needle-shaped crystals was obtained. These possessed an almost constant melting point, showing that only one substance was present, and were submitted to a rigid investigation to determine their properties and constitution.

Products obtained from the above operations—1,200 grams of fresh flowers, or 500 grams dried (at 100°C) material gave—

24 gms black resinous substance

32 gms of brick-red deposit after hydrolysis, consisting of phlobaphenes

2.3 gms of yellow pigment from the lead acetate pptn.

0.1 gms. of yellow pigment from the basic lead acetate pptn.

(2.4 gms of yellow pigment or 0.2% of the fresh flowers)

A solution containing the glucosidal sugars.

A brownish yellow amorphous substance from the mother-liquors after crystallisation of the yellow pigment.

Deep crimson coloured aqueous solutions exhibiting the properties of anthocyanins.

A viscid oil of strong acid odour, obtained from the ether extract after the yellow pigment had been removed by alkali.

(a.) *The soluble yellow pigment*

In order to complete the purification of the yellow substance the whole was converted into its acetyl derivative, by boiling with acetic anhydride and sodium acetate. The compound separated from water as a brown crystalline mass, and after purifying with charcoal and recrystallising many times from hot alcohol, a pure white product was obtained. The acetyl derivative possessed a constant melting point, and was afterwards quantitatively hydrolysed. The yellow pigment obtained in this way was now assumed to be pure.

(1) *Properties*.—The substance appeared under the microscope as beautiful masses of crystals, fine hair-like needles of a pale lemon-yellow colour, and possessing a melting point of 274°C. By adding a drop of ammonia to 10 c.c. of a solution containing the smallest speck of the substance a deep yellow colour was produced; this is a characteristic reaction of flavones, which have little colour of their own in the glucosidal condition.

Lead acetate produced a bright orange-red precipitate.

Ferric alum in alcoholic solutions gave a purple colour

Sulphuric acid dissolved the pigment to a bright yellow solution which, on standing some hours, exhibited a bluish-green fluorescence

These indications that the substance belonged to the flavone group were confirmed by the following quantitative results

(2) *Sulphuric acid derivative*—The substance, in acetic acid solution and under anhydrous conditions, united with sulphuric acid and yielded a mass of bright orange-red crystals in the form of minute thin needles. These when purified were found to decompose quantitatively, yielding the original substance.

0.1695 gm. compound gave 0.1262 gm. pigment, = 74.45 %

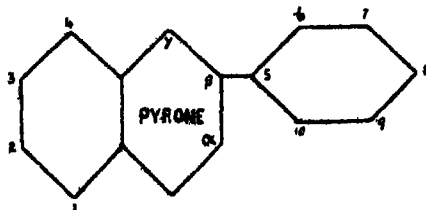
0.0704 " " 0.0524 " = 74.43 %

74.45 % of pigment represents a Mol. Wt. of 285.8

$C_{15}H_{10}O_6$ requires 286

Five different flavones are known possessing this formula

The property of combining with mineral acids in this way is probably a general reaction for the yellow colouring matters of the pheno- γ -pyrone class as has been pointed out by Professor A. G. Perkin. This property has been shown to be due to the oxygen atom in the pyrone ring becoming quadrivalent, and is also said to be characteristic of the γ -pyrone ring



Text-fig. 1 Skeletal structure of the Flavones

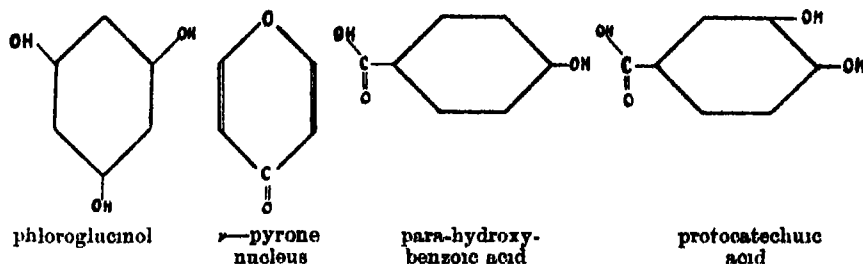
(3) *Disruption of the Pyrone Nucleus*—In order to determine the nature of the benzene rings attached to the pyrone nucleus, the yellow compound was submitted to fusion with potassium hydroxide at 200°C . From the product, phenols and acids were separated. In the former, phloroglucinol was identified by its reactions and by the crystals of the tribromo derivative. The solution of organic acids gave with ferric alum a bluish-green colour, which changed to violet with sodium acetate, and to red with sodium carbonate, but no colouration was produced by ferrous salt. Protocatechuic acid gives these colour reactions, but it also gives a violet colour with ferrous sulphate.

The small amount of substance left, when recrystallised, separated in radiating clusters of white needle-shaped crystals, which gave a melting point of 192°C . (corr.). The discrepancy could not be removed at this stage, as the weight of material was quite inadequate for the preparation of salts or the molecular weight determination.

Later, a probable explanation was found in a paper by Hlasiwetz (Liebig's *Annalen der Chemie*, 1885, 276). Here protocatechuic acid was shown to form with paroxybenzoic acid a compound of constant composition and a constant melting point of 192°C . Ferric chloride, acting on the latter acid alone, produced a yellow colour, while the mixture gave the green of the former acid.

The results obtained by fusion of the yellow pigment with potash indicate,

therefore, the presence of phloroglucinol, para-hydroxybenzoic acid, and protocatechuic acid, among the products of decomposition



Text-fig. 2 Decomposition Products of Flavonols

The highly purified pigment was not used for this experiment it was reserved for the quantitative determination of acetyl and sulphuric derivatives. The sample of pigment used for the alkali fusion, from which it is not recoverable, consisted of the second and third crops of crystals, and although much time was spent in its purification it was subsequently found still to give faint colour reactions of tannins. In the later examination of the tannins protocatechuic acid was identified, and this is a possible source of the acid in the decomposition of the yellow pigment, since one only of these two acids can belong to the flavone molecule.

(4) *Acetylation*—The acetyl compound was prepared and purified. It consisted of fine, white, needle-shaped crystals of silky lustre, matted together into a net work, these were anhydrous after drying at 130°C , and melted at 179°C .

The number of acetyl groups in this compound was then determined by hydrolysis with sulphuric acid, and the yellow pigment thus set free was deposited in its original form.

0.0327 gm acetyl derivative gave 0.0201 gm pigment = 61.5%

1.3100 " " 0.8075 " = 61.6

In a substance of molecular weight 286, this result represents four acetyl groups. The original substance therefore contains four hydroxyl groups in its molecule.

Kaempferol contains 4 (OH) groups, and tetra-acetyl kaempferol melts at 181°C .

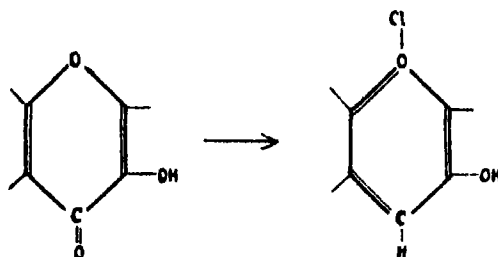
(5) *Methoxy-groups*—The testing for CH_3O -groups was carried out by Perkin's modification of Ziesel's method, but no methyl iodide was evolved, and the pigment was recovered unchanged from the mixture. Methoxy-groups are therefore absent from the molecule of the substance.

(6) *Oxidation*.—The substance dissolved in dilute soda to a yellow solution. From this liquid the pigment could at first be reprecipitated by acid, but when a current of air was aspirated through the solution for 24 hours, a profound change was noted: the colour became dark brown, and the pigment which was no longer precipitated by acid could not be detected in, nor recovered from the solution. Evidently it had been decomposed by oxidation and, when agitated with ether, a crystalline substance was obtained, which gave the reactions of phloroglucinol.

The nature of this result was shown by Perkin to be due to a particular hydroxyl group in the α position of the pyrone nucleus, the presence of which in a flavone molecule characterises the subgroup of the *flavonols* (see Text-figs. 1 and 3).

(7) *Metallic derivative*—The preparation of a flavonol potassium salt was unsuccessful. A very dark precipitate formed, which settled as an indian-red coloured granular powder, the superfluid being deep red. This granular deposit showed the same melting point as the yellow pigment. The typical orange prisms said to be obtained from the flavonols could not be prepared in this case, and one may conclude that the acidic properties of the substance in question are so feeble that the compound with a metal is difficult to form.

(8) *Conversion of Flavonol to Anthocyanidin*.—When we compare the molecular configuration of yellow flavonols with red anthocyanidin pigments, it is observed at once that the difference, though fundamental, is very slight. Theoretically, in passing from one to the other, the change takes place in the two opposite atoms of the pyrone ring, where the oxygen atom changes in valency from 2 to 4, and the CO group is reduced to CH.



Text-fig. 3. Pyrone nucleus, showing change from flavonol to anthocyanidin.

Such a change was effected practically by treating the alcoholic solution of the yellow pigment with nascent hydrogen. The colour at first became green, then changed suddenly to a brilliant red.

This product may be described as an artificial anthocyanidin, a reduced oxonium salt from flavonol. It exhibited all the general properties of anthocyanidins. When the red alcoholic solution was exposed to air and light it soon became colourless, owing to some allotropic change. When very dilute ammonia was added to the fresh red solution, a blue colour appeared, and with the decolourised solution yellow was formed, the other stages giving mixed green reactions due to both forms. When the red solution was agitated with acid and amyl alcohol the red pigment passed into the latter solvent. The red amyl solution was separated and, on the addition of a drop of sodium carbonate, a change of colour was observed, the solution passing rapidly from blue to green. Finally the alkaline amyl solution was shaken up with water, when the red anthocyanidin suddenly went back into the aqueous solution.

(b) *The Sugar of the Glucoside*

It has been shown in the process of extraction of the yellow flavonol that the latter did not exist in the free state in the plant, but was present in the form of a glucoside.

The sugar resulting from the hydrolysis of the glucoside was extracted from the aqueous solution set aside for that purpose. Impurities were removed by treatment with lead acetate, barium carbonate, and animal charcoal, and the sugar, finally obtained as a mass of white crystals, was submitted to the following examination:—

- 1 anaphthol—a violet colour at once.
- 2 Fehling's solution—immediate reduction (reducing sugar)
- 3 Nitric acid oxidation—no mucic acid formed (absence of galactose)
- 4 Boiled with sulphuric acid—methyl furfural was evolved which gave the yellow aniline acetate test, changing to red with acid.

The sugar, thus shown to be a methyl-pentose, was subsequently proved to be *rhamnose* from the properties of its osazone.

The osazone crystals were purified by six crystallisations from dilute alcohol, and then fractionated. The first and last fractions had melting points of 187° and 188°C respectively. There was therefore only one compound present.

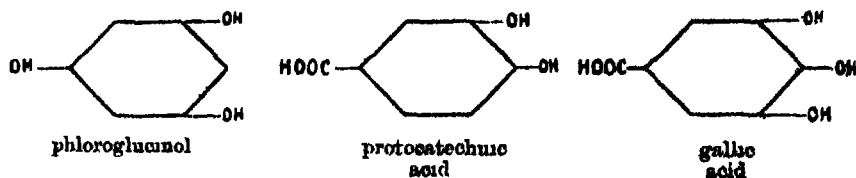
The melting point of *rhamnose* has been recorded by E. Fischer as 185°C, and by Votocek as 186°-187°C.

(c) The Tannins

The aqueous extract of the flowers, when hydrolysed by boiling with acid and allowed to cool, deposited a large amount of a dark reddish-brown granular substance. Certain small glassy prisms, which resembled gallic acid, were also observed in the fluid while cooling. These crystals were subsequently isolated from the ethereal solution, and when purified, gave a melting point of 220°C. The properties and reactions conformed entirely to those of gallic acid.

The red deposit was next examined.—When shaken with hot water it went into a fine suspension, and on cooling the red deposit settled again. It was soluble in alcohol, and also in water containing a little ammonia.

The dry red powder was fused with potash at 200°C, and from the acidulated aqueous solution the products of decomposition were extracted with ether. From this extract, phloroglucinol, protocatechic acid and gallic acid were isolated.



Text-fig. 4 Decomposition Products of Tannins

The red substance was therefore shown to be the phlobaphene, or red anhydride of a tannin of the catechol group and contained, as part of its composition, phloroglucinol and protocatechic acid. Gallic acid, on the other hand, is generally regarded as indicating the presence of a gallo-tannin. But A. G. Perkin has recorded a rare exception in the tannin of *Pistacia*, a small European tree (mastic tree), which gave both a red phlobaphene of the catechol series, and also gallic acid and phloroglucinol when fused with potash. Gallic acid has also been identified free in certain plants.

The results obtained indicate either the presence of two different groups of tannins—a gallotannin and a catechol tannin—or one similar to the rare instance mentioned, which appears not to coincide with the present classification of the tannins.

The deep red-coloured fluids obtained all through this work owe their colour to a certain extent to the phloroglucin in the tannin molecule. During the acid hydrolysis, pentose sugars are formed from various sources such as lignin,

pentosans, and the rhamnose glucoside. These give the phloroglucin red when heated with acid.

(d). *The Anthocyanins.*

The aqueous extracts after boiling with acid were bright red in colour. This red acid solution, when filtered from the insoluble red tannin decomposition products, was found to be partially soluble in ether, and to follow the flavonol into that solvent. When subsequently the ether was removed by distillation, the residue consisted of yellow crystals of flavonol, and also a granular deposit of red colouring matter. The latter was obtained in the mother-liquors from the crystallisation of the flavonol, and was separated by extraction with amyl alcohol. From this solvent, acidulated water did not remove the red pigment, but when made alkaline with sodium carbonate, the red colour passed into the aqueous solution and left the alcohol colourless. By neutralising with acid, the red colour could be shaken again into the amyl alcohol solution. Petroleum spirit precipitated the red colouring matter and, when left exposed to the air for a few days, the red colour entirely disappeared. Bromine water gave no precipitate in the acid solution (distinction from tannin red).

Spectrum absorption bands—The amyl alcohol solution of the red pigment showed absorption of light rays in one region only, this included the violet, blue, green, and yellow rays up to λ 515 $\mu\mu$, i.e., a little beyond the D line of sodium.

(e) *The Plastid Pigments*

When *Acacia discolor* is in full bloom two different tints of yellow may be observed in the inflorescence: the anthers possess a shining golden yellow colour, while the long filaments are tinted pale cream. If fresh flowers be submitted to the action of ammonia vapour the flavone reaction at once appears, and the previously pale parts of the stamens assume the characteristic deep yellow tint. If some cut flowers be laid aside for a few days and afterwards examined with a lens, the withering is seen in the pale filaments which have become brown, while the bright yellow of the anthers persists. The brown portions now respond much less to the action of ammonia, for probably the flavonol pigment has been partly oxidised.

The unchanged golden yellow parts are most probably those in which the colour is fixed in the chromoplasts as carotin and xanthophyll.

For the purpose of obtaining some knowledge of the approximate amount of these plastid pigments present in the flowers, some air-dried material was finely powdered and extracted. The first treatment with boiling water was repeated until all soluble colour was removed. The residue was then extracted with hot alcohol, which gave a dark brown solution.

This, on standing, deposited much flocculent and gelatinous matter which was removed, and the solvent distilled off. Ether then dissolved the colouring matter from the residue, and this solution contained chlorophyll as shown by its absorption spectrum, although, to all appearance, no stalks or green parts were included in the sample. Small amounts of chlorophyll therefore are contained in the yellow flowers.

In order to remove the chlorophyll from the solution of combined plastid pigments, these were saponified in cold alcoholic potash. By this means the yellow pigments were left unchanged, and were extracted from the aqueous solution by

other The carotin and xanthophyll were then obtained by distillation of the ether, and were dried and weighed

The amount of carotin and xanthophyll obtained was equivalent to 0.9% of the (dried at 100°C) flowers

The spectrum absorption bands—The solution containing the three combined plastid pigments in ether, when examined by the spectrometer, showed absorption bands in the following regions—

violet up to λ 452

the red band 650-672

707 μ into the infra-red

The ethereal solution of the carotin and xanthophyll showed the complete absorption of the violet and blue rays from λ 495 μ

II *Acacia linifolia*

The flowers of this species are of a very pale cream colour. The material for examination was collected at Cheltenham, Chatswood and Sutherland, in the month of June

About two kilograms of the air-dried flowers were extracted by the methods previously described. In this case again no flavone in the free state could be detected. After hydrolysis with acid as before the solution deposited a considerable amount of red phlobaphene, and ether then removed a yellow pigment. This was obtained pure only after considerable trouble, the purification being persistently interfered with by the close association of a buff-coloured, amorphous substance.

The flavonol pigment—Most of the yellow pigment was obtained by extracting the solid phlobaphenes with ether. From 2 kilograms of flowers, about half a kilogram of phlobaphene was obtained, which was five times the amount found in *A. discolor*.

The yellow pigment when obtained pure consisted of pale yellow, needle-shaped crystals. At 275°C (cor) the crystals melted and blackened. The acetyl derivative gave a melting point of 180°C. (cor)

These two fundamental properties—the melting points of the flavonol and the acetyl-flavonol—are taken as evidence that this pigment is identical with that of *A. discolor*, and that it is kaempferol.

The yield of flavonol was about 3 gms, or 0.17% of the material used.

The acetyl derivative contained 59.6% of pigment and the sulphuric oxonium salt yielded 75.8% of pigment. These two figures however do not show a distinction between kaempferol and quercetin, and it is not always possible to ensure complete precipitation.

The buff-coloured amorphous precipitates were dissolved in dilute alcohol and set aside for some weeks. No crystals were formed and the solution was colloidal, passing through a filter without any residue. It was boiled with acid for some time and treated with a number of solvents, but no crystals were obtained from any of these.

The Plastid Pigments

Finely powdered flowers were extracted as in the case of the former plants, by first removing the water-soluble pigments. The alcoholic extract was green and showed a brown fluorescence with indirect light. When the solvent was removed the residue was green and brown. The ethereal solution of the residue was examined by the spectrometer, and showed the chlorophyll bands at C and F-G. When this solution was saponified until the C band had entirely dis-

appeared, pure carotin and xanthophyll were obtained, their ethereal solution was a bright yellow colour and showed the characteristic absorption spectrum beginning at λ 490 $\mu\mu$ and extending into the ultra-violet region.

From 26 gm of the air-dried flowers 0.26 gm or 1% of combined pigments was obtained, and an approximate separation of these gave as the result 0.75% of carotin, and 0.25% of xanthophyll.

III *Acacia decurrens*, var *mollis*

The golden yellow flowers of *A. decurrens* were collected at Ryde and Eastwood, in the month of December.

The fresh material was treated at once by the methods previously described, and 0.06% of yellow pigment was obtained. This was purified, as before, from the anthocyanidin and tannin in solution, and gave all the reactions for flavonol similar to the two previous cases. The melting point of this pigment was 274°C and its acetyl derivative melted sharply at 181°C (cor).

The yellow pigment of *Acacia decurrens* is thus shown to be identical with that from the other two species.

In the course of this investigation it was observed that again the flavone pigment was present in the flowers entirely as glucoside, since no pigment could be extracted by ether before hydrolysis with acid. The ethereal solution containing the colouring matter, when shaken out with ammonium carbonate, yielded a mass of brown flaky crystals, which were purified by crystallisation after heating with animal charcoal. The purified substance was obtained in fine glassy crystals. They consisted of exceedingly thin prisms, some of which were 2 cm long, and possessed a constant melting point of 179°C. The substance was insoluble in cold water, but required 100 parts of boiling water for solution, and was more soluble in alcohol. The solution gave no colour reaction with ferric chloride, and possessed no odour and no taste. This substance proved to be an organic acid, since it formed barium and silver salts.

From the first flavonol crystallisation the mother-liquor, on standing, yielded a mass of long needle crystals, which were readily soluble in alcohol, ether, and hot water and which, when purified, melted sharply at 222°C. This substance was proved by its reactions to be gallic acid. Since it was absent from the original extract it was formed during the acid hydrolysis, and probably from the tannin. As in the case of *A. discolor*, the gallic acid points to the existence of a gallotannin, in addition to the catechol tannin which yields the red phlobaphenes.

IV *Acacia longifolia*

The "Golden Wattle," *A. longifolia*, was collected at Mount Victoria, in January.

An extract of the flowers, when treated by the previous methods, showed that the flavonol was in the form of glucoside, and that no free pigment was present. When hydrolysed by boiling with sulphuric acid the solution became deep red and deposited, on cooling, the red phlobaphenes as in the three previous cases.

The ethereal extracts presented a peculiar appearance, for, in place of the deep yellow solutions obtained in the other species, this solution by transmitted light was quite colourless, while in reflected light it appeared to be brilliant purple. On evaporation of the ether a yellow and red crystalline deposit remained. It appeared strange that an ethereal solution of flavonol should be entirely devoid of yellow colour. The crystals were dissolved, in this case, in hot

acidulated water, and afterwards an equal bulk of amyl alcohol was added. The amyl alcohol solution was red and contained anthocyanidins, while the yellow flavonol pigment was insoluble. By the above means the greater part of the red colouring matter was removed, and the lemon-yellow crystalline mass was re-crystallised from alcohol until the mother-liquors were colourless. The yield of pure yellow flavonol was 0.062% of the fresh flowers.

The flavonol crystals melted at 276°C.

The acetyl derivative " " 181°C.

These properties are possessed by kaempferol.

The mother-liquors from the flavonol crystallisation were concentrated and, after standing some time, were found to deposit no more of this lemon-yellow pigment, but instead there was obtained an amorphous yellowish-brown substance. When this was redissolved in dilute alcohol and allowed to separate on cooling the process being repeated a number of times, the substance obtained was still amorphous. It was dried at 100°C and gave a melting point of 237-240°C. It was very soluble in cold alcohol, and with iodine solution gave no blue colour.

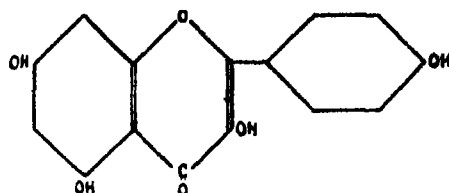
Plastid Pigments—The combined carotin and xanthophyll amounted to 0.43% of the (air-dried) flowers.

CONCLUSIONS

The water-soluble yellow pigments isolated from the flowers of *Acacia discolor*, *humifolia*, *decurrens*, and *longifolia*, are shown by the following data:—

<i>Acacia</i>	<i>discolor</i>	<i>humifolia</i>	<i>decurrens</i>	<i>longifolia</i>	kaempferol
m.p. of flavonol	274	275	274	276	274
m.p. of acetyl deriv	179	180	181	181	181

The substance is proved to be a flavonol glucoside possessing the properties and reactions of kaempferol and rhamnose.



Text-fig 5 Kaempferol

In addition to this compound the yellow plastid pigments carotin and xanthophyll are present in different amounts. It is noteworthy that *Acacia humifolia*, with the palest yellow flowers, contains the largest amount of carotin and xanthophyll, while less than half the amount was obtained from the deep golden yellow flowers of *Acacia longifolia*.

In conclusion, the author desires to express his indebtedness to Professor H. G. Chapman for affording laboratory accommodation and facilities for carrying out this research.

SUMMARY

The results of this investigation may be summarised as follows:—

Four different species of endemic acacias have been examined to ascertain the nature of the colouring matter of their yellow inflorescence.

The water-soluble yellow pigments isolated from each species were identical, and were proved to be a glucoside of kaempferol. It consisted of fine hair-like needles of lemon-yellow colour. In exceedingly dilute solutions alkali produced a very deep yellow colour, and in strong sulphuric acid the yellow solution exhibited a bluish-green fluorescence.

Sulphuric acid formed an oxonium salt of bright orange crystals from which, by quantitative decomposition, the molecular weight of the pigment was obtained as 286.

By fusion with potash, phloroglucinol, parahydroxybenzoic acid and protocatechuic acid were identified, the two acids being combined as a compound of constant composition, with m.p. 192°C.

The kaempferol exists in the flowers as a rhamnose glucoside; no free flavonol was found.

The yellow flavonol could be transformed by nascent hydrogen to a red solution, the properties of which resembled those of the natural anthocyanidin also isolated from the plant extracts.

The acacia tannins were composed of phloroglucinol, protocatechuic and gallic acids, and deposited on hydrolysis large amounts of the red phlobaphene anhydrides.

The carotin and xanthophyll as plastid pigments were present in amounts from 0.14 to 0.3%, and the flavonol about 0.06% of the fresh flowers.

STUDIES IN LIFE-HISTORIES OF AUSTRALIAN DIPTERA BRACHYCERA

PART II ASILIDAE

No 1 Catalogue of the species of *Asilidae* of which the earlier stages have been recorded, with literary index, and bibliography of biological literature

By VERA IRWIN-SMITH, B Sc, F L S, Lannean Macleay Fellow of the Society in Zoology

[Read 29th August 1923]

The following catalogue is uniform in treatment with that dealing with the Stratiomyidae, which was given in the first paper of this series (Proc Linn Soc. N S W, xlv. 1920, p 522). It is intended to form an historical introduction to the biological study of the group with which it deals, and to serve as a practical guide to all the work done previously on the subject. Like the first catalogue, it is based on much earlier general works and catalogues. Among the most important of these are Westwood's Modern Classification of Insects (1840), Habbaday's Lists (1857), and Brauer's Catalogue (1883). The very useful work of these old authors has been revised and carried forward, largely with the assistance of the Zoological Record, and is now brought up to date and made as complete as possible by reference to the catalogues of the Royal Society and the British Museum, and to such dipterological works as are available to me.

Several important general works, containing sections on the early stages of Diptera Brachycera, have appeared in recent years, some of which I had not had an opportunity of seeing when the Stratiomyid catalogue was compiled. Of these, the most important are various papers by J R Malloch, and by J C H de Meijere. Malloch's synoptic treatise with its analytical keys to the immature stages of Diptera (1917), is an invaluable work of reference (for students of the life-histories), and I have found the condensed information which it supplies of great assistance in the study of the Brachycera. Other useful general works, of an earlier date, are those by Perris (1870), Beling (1882), Lundbeck (1908), Verrill (1909) and Patton and Craig (1913).

But, as with most of the Brachycera, the descriptions of the immature Asilidae in these works are confined almost entirely to the external features of larvae and pupae, and little more has been attempted in papers dealing exclusively with this group. And, as will be seen from the catalogue, the number of species of which even this limited biological knowledge exists is still very small.

No record has been published, hitherto, of the early stages of any of the Australian species.

In the following catalogue no attempt has been made to deal with synonymy. The species have been listed under the names given by the authors referred to. Full references to the literature are given in the bibliography attached, which is arranged in chronological order, and, in the list of species, the authors are quoted only with date and page of work.

CATALOGUE

- Asiidae* (general) — Brauer, 1883, pp 28-29, Malloch, 1915, 337-340, figs, Malloch, 1917, 373-374
- Andrenosoma atra* — Perris, 1870, 218-222, Pl 3, Brauer, 1883, 64
- Asilus* Linné (generic) — Perris, 1870, 220, Malloch, 1917, 385
- Asilus aestivus* — Harris, 1776, Walker, 1851, 51, Haliday, 1857, 184, Perris, 1870, 220, Brauer, 1883, 64
- Asilus atricapillus* Fall — Beling, 1882, 202, Brauer, 1883, 64, Lundbeck, 1908, 56, (see *Machimus atricapillus*)
- Asilus barbarus* — Mayet, 1806, lxiv
- Asilus crabroniformis* — Frisch, 1721, 35, Pl 1, taf 8, fig 1, Walker, 1851, 55, Haliday, 1857, 184, Brauer, 1883, 64, Xamheu, 1899, 55, Xamheu, 1904, 174
- Asilus (Itamus) cyanurus* — Harris, 1776, Beling, 1882, 204, Brauer, 1883, 64, figs 52-53, Lundbeck, 1908, 81 (see *Neotamus cyanurus*)
- Asilus (Eptiriptus) ?* sp — Brauer, 1883, taf iii, fig 56
- Asilus forcipatus* — Frisch, 1721, pt 3, De Geer, 1778, 236, Pl 14, figs 5-9, Dufour, 1850, Walker, 1851, 52, Haliday, 1857, 184, Brauer, 1883, 64
- Asilus gemculatus* L. — Beling, 1875, 42-43
- Asilus germanicus* — Ratzeburg, 1837, 155, Pl x, fig 12a-b, Walker, 1851, 55, Haliday, 1857, 184, Brauer, 1883, 64
- Asilus notatus* Wied — Malloch, 1915, 340-341, Pl lxxxv, figs 6, 7, 14, 17, 18, Malloch, 1917, 375, 377, 385, Pl liv, fig 10
- Asilus sericeus* Say — Malloch, 1917, 377, 386, Pl lv, figs 2, 3, 10
- Asilus* spp — Harris, 1776, t 17; Westwood, 1840, 549, fig 129, 15, 16, Zetterstedt, 1851, 16, Perris, 1870, 220, Hubbard, 1880, 250, Brauer, 1883, 64, figs 52-57.
- Ceraturgus* Wied (generic) — Malloch, 1917, 379
- Ceraturgus cruciatus* Say — Malloch, 1917, 376, 379-380, Pl lv, fig 1, lv, figs 3, 4, 6, 8
- Dasyllus* Loew (generic) — Malloch, 1917, 380-381
- Dasyllus thoracica* — Greene, 1918, 149, Pl xviii, figs 1-2
- Dasyllus* sp — Malloch, 1917, 382, Pl lvi, fig 8, Pl lv, fig 1-2
- Dasyllus* sp. — Malloch, 1917, 381, Pl lv, fig 12
- Deromyia philippi* (generic) — Malloch, 1917, 384
- Deromyia discolor* Loew — Malloch, 1917, 375, 376, 384-385, Pl. liv, figs 7, 11
- Deromyia winthemi* Wied — Malloch, 1915, 338-339, Pl lxxx, figs 14, 15, 16, Malloch, 1917, 376, 385
- Dioctria* Meig (generic) — Lundbeck, 1908, 17.
- Dioctria baumhaueri* Meig — De Meijere, 1916, 218, figs 84-88
- Dioctria flavipes* Meig — Beling, 1882, 197; Brauer, 1883, 64
- Dioctria hyalipennis* Fabr — Lundbeck, 1908, 25.
- Dioctria linsaris* Fabr. — Beling, 1882, 199; Brauer, 1883, 64
- Dioctria oelandica* L. — Beling, 1882, 196, Brauer, 1883, 64.

- Dysmachus forcipula* Zeller—Lundbeck, 1908, 56-57, 71
Dysmachus trigonus Meig—Lundbeck, 1908, 56-57, 73-74, De Meijere, 1916, 220-221, figs 89-91
Eraz aestuans L—Malloch, 1917, 377, 388, Pl lv, figs 6, 7, 9
Eraz bastardi—Riley, 1870, 121, Brauer, 1883, 64
Eraz maculatus Macq—Malloch, 1917, 377, 387, Pl lv, figs 4, 5, 8
Helgmonoura brunipes Poulton, 1914, chx (habits)
Holopogon fumipennis—Frauenfeld, 1866, 976-977, Brauer, 1883, 63
Holopogon nigripennis—Mik, 1885, 328 (habits)
Laphria atra—Peris, 1870, 212-218
Laphria flava—Scholtz, 1848, 16, Brauer, 1883, 64, Lundbeck, 1908, 47
Laphria gilva—Brenn 1842, Dufour, 1849, Peris, 1870, 212-218, Pl 3, figs 89-96, pp 218-222, Beling, 1882, 199, Brauer, 1883, 28 63, fig 61, Lundbeck, 1908, 45-47
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Laphria maroccana—Lucas 1848, 82 83, Brauer, 1883, 64
Laphria meridionalis Mulsant and Reyher 1859, 119-123, Peris, 1870, 219, Brauer, 1883, 64
Laphria spp—Zeller, 1842, Lucas, 1848, Dufour, 1849, Walker, 1851, 47, Haliday, 1857, 184, Verrill, 1909, 38, fig 66
Laphyra sp—Seurat, 1900, 30-31
Lasitopogon cinctus Fabr—Lundbeck, 1908, 37-39
Leptogaster Meig (generic)—Lundbeck, 1908, 10
Leptogaster cylindricus—Beling 1875, 42-43, Beling, 1882, 195, Brauer, 1883, 64
Leptogaster flavipes Loew—Malloch, 1917, 375, 377-378, Pl lvi, figs 6, 7
Machimus atricapillus Fall—Lundbeck 1908, 56
Mallophora orcina Wied—Riley, 1880, 262, Brauer, 1883, 64
Neoaratus hercules Wied—Irwin Smith (Proc Linn Soc N S W, 1923, Pt. 3).
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Proctacanthus Macquart (generic)—Malloch, 1917, 385
Proctacanthus milberti Macq (?)—Malloch, 1915, 339-340, Pl lxxxi, figs 1, 3, 6, 7, 19, 22, Malloch, 1917, 377, 385
Proctacanthus philadelphicus Packard, 1870, 22, fig, Malloch, 1917, 377, 385
Promachus Loew (generic)—Malloch, 1917, 383
Promachus fitchi Ost-Sack—Malloch, 1916, 66-68, Malloch, 1917, 375, 383-384, Pl liv, fig 5
Promachus vertebratus Sav—Malloch, 1915, 337-338, Pl lxxxii, figs 5, 11, 12, 13, 14, 20, 24, 25, Malloch, 1916, 66-68, 1917, 375, 384
Promachus sp—Patton and Craig, 1913, 308, Malloch, 1917, 376
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STUDIES IN LIFE-HISTORIES OF AUSTRALIAN DIPTERA
BRACHYCERA

PART II ASILIDAE

No 2 Notes on the egg-laying, eggs and young larvae of *Neoaratus hercules*
Wied

By VERA IRWIN-SMITH, B.Sc. F.L.S., Linnean Macleay Fellow of the Society in
Zoology

(Eighteen Text-figures)

[Read 29th August 1923]

NEOARATUS HERCULES Wied

Wied, Auss zweifl Ins, 1, 1828, p 425 (*Asilus*). Macq, Dipt exot, suppl 1, 1846, p 82 (*Erax*), Walk, Last Dipt Brit Mus vii, suppl 3, 1855, p 643 (*Erax*), and p 753 (*Asilus*) — *Asilus phicatus*, Wied, Auss zweifl Ins. n, 1830, p 643, Froggatt, Australian Ins, 1907, p 299, Kertész, Catal Dipt, iv, 1909, p 271 (*Aratus*), for full list of early refs, Ricardo, Ann Mag Nat Hist (8), xi, 1913, p 437 (*Neoaratus*), Hardy, Proc Linn Soc N S W, xlv, 1920, p 251; xlv, 1921, p 296

On December 16th, 1921, a female of this species was captured on the window of a room in the writer's home at Lane Cove, Sydney. It was left alive for several days in a glass tumbler inverted over a sheet of paper on the window ledge and, on the third day, December 19th, a large mass of eggs was observed covering one side of the paper and closely adherent to it. The female was left undisturbed for several days longer, but no more eggs were laid after the first batch and, on the morning of December 22nd, the paper bearing the eggs was transferred to the top of damp soil in a glass jar, and the female, which was still quite active and healthy, was killed with chloroform and set.

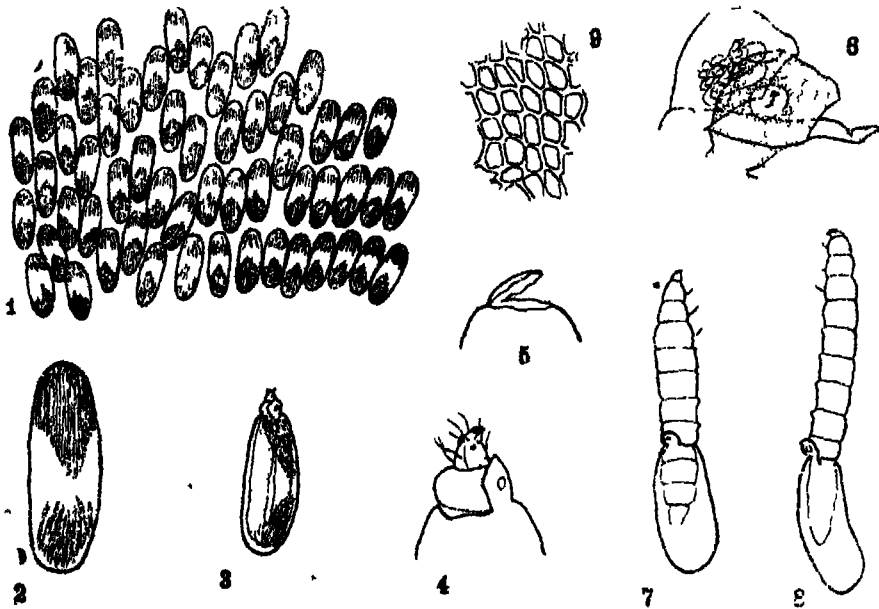
When first observed, the eggs were light creamy coloured, but they soon darkened to a yellowish-brown, and by December 21st had become much darker at one pole. After being for two days on the soil, the paper, made very damp by contact with it, was already becoming infested with fungus, so it was thought advisable to dry it completely, and on December 24th when quite dry, it was transferred, with its egg mass undisturbed, to a dry, empty petrie dish. At 9 a.m. on the following morning, December 25th, large numbers of larvae were found already hatched or in process of hatching, and throughout the day the hatching continued without cessation, the larvae emerging half-a-dozen at a time. They were still emerging in large numbers at 10 a.m. next morning, December 26th, when the remaining mass of newly hatched larvae and empty and full eggs was fixed in boiling Carl's solution.

The larvae showed themselves very active from the moment of emergence, crawling rapidly away from the egg mass, and dispersing in all directions. As soon as the hatching was observed, the paper, with eggs and larvae, was placed in a glass jar containing slightly damp soil and some pieces of the *Scarabaeidae* larvae known popularly as "white curl grubs" and other things which might prove suitable as food. But, while some of the larvae burrowed into the soil the majority crawled over its surface, and swarmed up the sides of the glass vessel, worked their way round the edges of the loose glass stopper covering it, and dropped to the table on which it was standing. Here they continued their rapid and apparently purposeful progress and, when not intercepted, dropped to the floor. It was evident that they were seeking their natural habitat and food, but what this was could not be ascertained. All kinds of soil were tried, sandy, loam, and vegetable mould, with varying degrees of humidity, and all kinds of flesh food, including coleopterous larvae, earthworms and scraps of meat, but nothing appeared to suit them. During the next few days errant larvae were swept up frequently from the table and floor with a fine camel's hair brush and restored to their pots. But they continued to make their escape, showing surprising agility in climbing up the sides of glass vessels 4 to 8 cm. deep. Finally, in order to prevent the loss of the entire batch of living specimens, they were confined in a large glass bottle, which was usually kept tightly corked but had a large air space above the narrow layer of fairly dry soil at the bottom. In this they remained alive for some time, being still very active and healthy when examined on January 20th, twenty-five days after hatching, although they were still the same length as when first hatched. But before the end of another month they had all died and shrivelled up, apparently, for no trace of them could be found when the soil was again turned out and examined on February 27th.

Oviposition.—The fly could only be watched in the mornings and evenings, and the actual process of egg laying was not observed. No eggs had been laid up to the evening of December 18th, so that oviposition must have occurred some time during the 19th. The eggs were laid for the most part in a single broad layer, in fairly regular parallel rows, lying flat against the surface of the paper, to which they were attached by some strong adhesive substance. Towards the margins of the layer the rows became much less even (Text-fig 1), and at one edge the eggs were piled up in a loose, irregular mass, but even here they were glued firmly together, so that it required a little force to detach them. Eggs placed in alcohol attached to the paper still retain their position after many months immersion in the liquid, and are not displaced by shaking. The entire mass was carefully counted and found to contain 705 eggs.

Incubation and hatching.—After oviposition the period of incubation occupied from six to seven days, and the hatching of the larvae extended over considerably more than twenty-four hours. The whole process of hatching was watched under the microscope. The embryo, when fully formed, lay doubled in two in the egg, with the head and tail close together just below the micropyle (Text-fig 3). For some little time before emergence, a restless movement could be detected within the shell. Finally, a circular cap was thrust up from the anterior end, and the larva emerged in a swift continuous movement, through an aperture so small in diameter that the body was markedly constricted as it passed through it (Text-figs 7, 8). The position of the emerging larva, relative to the shell, was not constant, sometimes the dorsal surface being uppermost, sometimes the ventral. The cap, or operculum, in all cases remained attached to the shell along its dorsal side, which constituted a sort of hinge for it, on which it moved, forming

a well fitting lid to the empty shell (Text-fig 5). The edges were clean-cut, showing only some half dozen slight serrations, apparently indicating an equal number of strokes made by the larva in cutting it open, with the sharp chitinous



Text-figures 1-9

1 Portion of egg mass near margin ($\times 7.5$) 2 Egg, dorsal view ($\times 27$) 3 Larva in egg, beginning to hatch ($\times 15$) 4 Head of same protruding through aperture in shell ($\times 48$) 5 Cap of empty egg shell ($\times 48$) 6 Cap ($\times 100$) showing inner shell membrane detached from outer, and position of micropyle 7-8 Larvae in process of hatching ($\times 15$) 9 Sculpturing on chorion of shell

process borne on the dorsal surface of the head. The narrow canal of the micropyle, with a clear circular area round it, could be seen exactly in the centre of the cap.

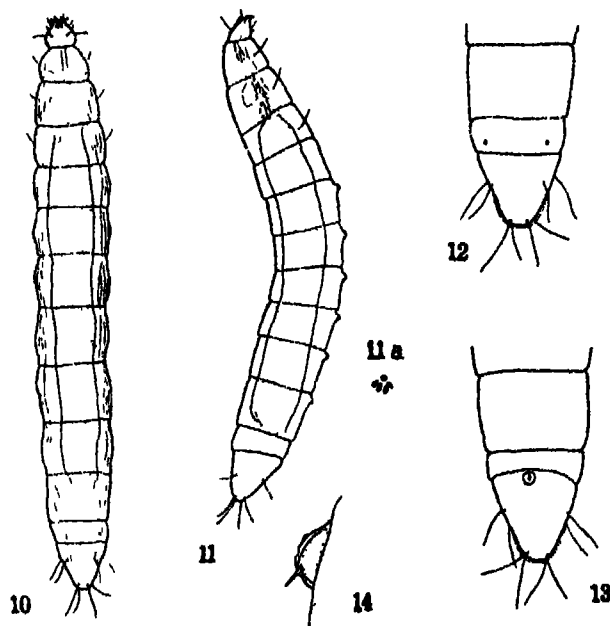
No regular order of emergence was observable, empty and full eggs being found, side by side in all the rows at any time during the hatching.

The egg.—The eggs (Text-fig 2) measure 1.12 to 1.23 mm in length, and 0.40 to 0.43 mm in width, and are somewhat bean-shaped, with broad, bluntly rounded ends, the end remote from the micropyle being the broader. The side which is attached to the paper is slightly concave, the upper side is convex, and is marked with a distinctive pattern in the form of a large brown patch towards each end, with a clear area between the two. The patch at the micropylar end is the longer and tapers to a point towards the middle of the shell. There is no colouration on the under, i.e., ventral, side. The brown patches are due to a somewhat streaky deposition of pigment in the inner shell membrane. This membrane (the coleum), though very thin and soft, is fairly tough and can be removed intact from the empty shell, when the brown patches show up plainly. The coloration is not dissolved by immersion in Carl's fluid, containing con-

centrated formol, glacial acetic acid and alcohol, or in alcohol, and the pattern on the eggs is still clearly visible after they have been stored for months in 70% alcohol. The pigment has the effect of making the shell somewhat opaque when viewed from the dorsal side, but the chorion itself is colourless and translucent. It has a delicate sculpturing in the form of a fine reticulum, roughly hexagonal in outline, which is only visible under fairly high magnifications (Text-fig. 9). The micropyle is surrounded by a well defined circular spot, where the oolemma is clear and colourless, in contrast with the deeply pigmented area round it (Text-fig. 6).

Young larvae—No ecdysis was observed in any of the larvae watched during the first day of hatching. The first larvae to be preserved were fixed at 6 p.m., i.e. nine hours after hatching was first observed. They included specimens just emerged from the eggs, and others swept up off the table, of which the exact age was uncertain, since larvae had been emerging continuously throughout the day. But they all have exactly the same appearance and are, apparently, still of the first instar. No measurements or accurate observations were made on the living larvae and the description and figures which follow are from specimens fixed in hot Carl's solution, and preserved in 70% alcohol.

First instar (Text-figs. 10-11)—The newly hatched larvae measure from 2.20 to 2.60 mm in length, and 0.26 to 0.30 mm in maximum width. The body is



Text-figures 10-14

10-11 Newly hatched larvae (x 30) 10 Dorsal view 11 Lateral view
11a Posterior spiracle (x 190) 12-13 Posterior end of body (x 118) 12 Dorsal view 13 Ventral view 14 Pseudopod of abdominal segment (x 190)

cylindrical, tapers slightly at each end, and is white and semi-transparent, only the chitinous tips of some of the head appendages being coloured brown. There are twelve distinct segments behind the head, all a little broader than long. The

penultimate segment is much shorter than the others and tapers ventrally to much less than its dorsal length, dorsally, its length is less than half its width and about half the length of the ultimate segment (Text-figs 12, 13). The ultimate segment is somewhat spatulate and quite colourless, without chitinated margin. It is broadly rounded at the apex, and bears eight long hairs, a dorsal and a ventral pair on the sides and two pairs close to the apex. On each of the three thoracic segments there is a pair of long hairs, measuring up to 0.11 to 0.14 mm in length, situated latero-ventrally. These evidently constitute the sensory structures which Keilin has shown (C. R. Acad. Sci., 153, 1911, p. 977) to be present on the thoracic segments of all dipterous larvae, and which he considers probably represent a last trace of larval feet.

The sides of each abdominal segment, from the first to the sixth, protrude slightly in a smooth rounded swelling, and abdominal segments 2 to 7 bear ventrally, close to the anterior margin, a pair of prominent, wart-like elevations, which serve as pseudopods. On its posterior face, each of these pseudopods bears a single short, stiff, sensory hair (Text-fig 14). With the exception of these hairs, the body segments are quite bare.

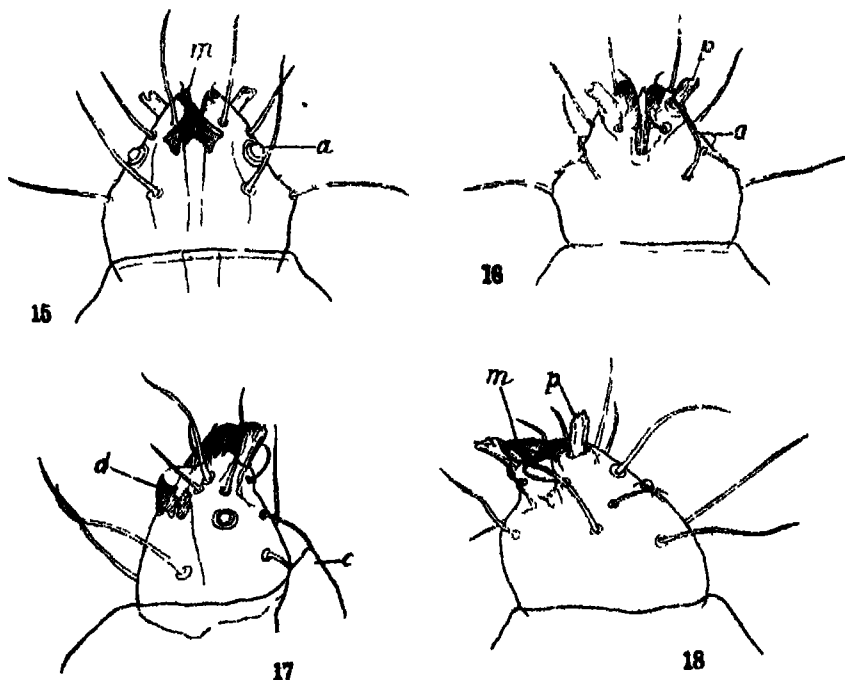
The prothoracic spiracles are extremely small and not easy to detect. They are situated laterally, close to the posterior margin of the segment. The posterior spiracles, situated behind the middle of the penultimate segment, are a little larger and, under high magnification, they are seen to consist of a group of four, possibly five, minute, clear, oval spots, the "Stigmentupfein" of de Meijere (Zool. Jahrb., xv, 1902, p. 624), arranged in a curve below a single circular spot of the same size and appearance (Text-fig 11a). The lateral abdominal spiracles are not distinguishable in these specimens.

The anal aperture is a small longitudinal slit, situated midventrally, immediately behind the junction of penultimate and ultimate segments.

As the body is semitransparent, the arrangement of some of the internal organs can be seen even in preserved specimens which have not been cleared. The middle intestine is large, and very distinct, owing to its opaque contents, which seem to consist of a quantity of yolk material. In the clear integument at the apex of the last segment, there are visible several very minute tubular bodies, which have the appearance of glandular ducts, but these structures have not yet been studied carefully.

The head (Text-figs 15-18) is relatively large, broadly conical, broader than long, and only very slightly retracted into the prothorax at its base. It measures in maximum width about 129 μ m and in length about 110 μ m. Its cuticle is still quite soft and colourless, the only chitinated portions being the tips of the maxillae and the median dorsal process. The maxillae (*m*) are large and well developed, having a triangular shape when viewed dorsally, but each prolonged at the apex into a ventrally curved, thorn-like spine, which is very sharp, strong, and heavily chitinated. The maxillary palpi (*p*) are stout and prominent, 0.28 mm long, and 0.11 mm in diameter, without distinct basal joint. Their apices are broad and truncated, terminated by two or three minute papillae. Mandibles and labrum are not distinguishable in the specimens examined. The antennae (*a*), situated laterally at the anterior third of the head, are two-jointed and very short, having the form of broad, rounded papillae. Mid-dorsally, towards the anterior, the head bears a sharp, narrow, blade-like, chitinous process (*d*) which, in all the specimens examined, has a colourless vesicle attached to its anterior edge. This process is probably peculiar to the first instar and acts as an egg-cutter. Seven pairs of very long hairs, 0.08 to 0.11 mm, are present on the head,

the most prominent of which are a dorsal, lateral and ventral pair situated about the posterior third. The others are two pairs, dorsally, at the base of the maxillae a pair just above the antennae, and a pair ventralwards from the an-



Text-figures 15-18 Head of newly hatched larva (x 175)

15 Dorsal view 16 Ventral view 17 Dorso-lateral view 18 Ventro-lateral view

a antenna, c cap of shell d dorsal process m maxilla, p maxillary palp

tennae. There are, in addition, a pair of much smaller hairs situated on the dorsal bases of the maxillae and one or two more on the cushion-like swellings at their ventral bases.

Imago—Mr G H Hardy, to whom I am indebted for the determination of the female fly captured, has written to me in reference to it that the species appears to be confined to sandy areas, and that he has found it at times in great numbers at La Perouse, near Sydney. He suggests that beetle grubs, probably Scarabacidae, are the chief food supply for the larva, in common with *Asilus* species known to have this habit. Unfortunately, the present investigation could not be carried sufficiently far to prove whether this is so in the case of the older larvae, the young larvae could not be induced to feed on them.

Specimens of the larva and pupa have been deposited in the Australian Museum, Sydney.

REVISION OF THE AMYCTERIDES (COLEOPTERA)

PART VIII THE EUOMIDES

By EUSTACE W. FERGUSON, M.B., Ch.M.

[Read 29th August 1923]

The *Euomides* as generally understood comprise all the short-scaped species of the Amycterinae. It is extremely doubtful, however, if the division thus made by Lacordaire (Gen. Coleop., vi, 1863, p. 309) into *Amycterides* *crassus* and *Euomides* is valid.

The group is a convenient one in many respects, but there seems to be no character, common to all the members, which will mark them off from the rest of the subfamily. The genera are for the most part very distinct from each other and exhibit a greater variety of form than is seen elsewhere in the subfamily.

The difficulty of defining the *Euomides* on the length of the scape was recognised by Pascoe who described several genera, of the location of which he was doubtful. There is, indeed, no absolute break in the series connecting genera with very short scapes with those genera like *Acantholophus* and *Phalidura* in which the scape is always long. One or two genera, in fact, in which the scape is recognisably long, are more closely allied to short-scaped genera than to the *Amycterides* *crassus*, *Polycratus*, for example is much closer to *Ennothus* and *Odontes* than to *Hyborrhynchus* and *Anasceptes*. *Chrotaphus* also is probably more at home among the *Euomides* than among the genera allied to *Talaurinus*.

The rostrum shows considerable variation in structure, particularly of the upper surface the two inner ridges which, in conformity with previous usage, I have continued to call the internal ridges, are always present, but in some species are raised into distinct crests. The clypeal plate, a small shining triangular plate at the apex of the rostrum, projects, in the majority of the genera of the group, rather strongly above or in front of the general level, whereas in the majority of the long-scaped genera it is more or less deeply sunken between the anterior ends of the external or marginal ridges of the dorsum. This character, however, is not constant, in *Euomus* the plate is intermediate in position, while in *Mythates* the plate is almost as deeply set as in *Talaurinus*. In *Leadrodes* the position is peculiar, the plate being set on the dorsum and hardly projecting above the general surface, though not deeply sunken. I have used the word exerted to describe the condition in which the plate projects more or less strongly.

The submentum is squarely cut, as maintained by Lacordaire, but in many of the species the margin is bisinuate or even strongly lobate in the middle.

Lacordaire is, however, on surer ground in speaking of the visibility of the mouth parts, usually in the Amycterides deeply sunk in the buccal cavity. 'Le

menton et les mâchoires sont moins enfoncées dans la cavité buccale et aussi visibles que dans le commun des Curculionides, par suite du moindre développement des mandibules"

It is possible that in these structures valid characters may be found for differentiating the group. The mandibles in particular require further study, in the majority of the species, if not in all, the end of one appears slightly to overlap the other. This is associated with the development of a dentiform projection on one side with a slight emargination above it. The condition reaches its maximum development in *Polycrcta*, in other genera, however, the divergence from the normal is so slight as hardly to be recognised.

The prothorax exhibits an extraordinary diversity of structure, in a manner not seen elsewhere in the subfamily, ocular lobes are generally present, though absent in a few genera.

The elytra also vary considerably, but present no characters for differentiating the group. The tarsi are as a rule relatively short, the posterior tarsi always being slightly longer, but in *Dialeptopus* the tarsal joints are very long and slender.

The male genitalia are comparatively simple in type in all the species. I have dissected, the aedeagus is of the common type found in the subfamily, while the eighth sternite is represented by two triangular pieces of chitin, not showing any tendency to the development of forceps.

In view of my inability to define the group, I have not attempted to tabulate the genera here reviewed, believing it preferable to leave tabulation until such time as the whole of the genera can be revised. I have included in the scope of this paper all the genera, with one exception, not previously dealt with in my revision. These genera are *Euomus*, *Mythites*, *Bubaris*, *Brachymycterus*, *Dialeptopus*, *Tetralophus*, *Cucullothorax*, *Alexirhea*, *Aedriodes*, *Melanegus*, *Atychoria*, *Sosytelus*, *Odatesus*, *Ennothus*, *Polycrcta*, *Acherres* and *Amorphorhinus*.

To this list I have added two new genera. The exception mentioned above is *Opetiapteryx*, and it is omitted from the revision because I do not regard the genus as belonging to the subfamily, the reasons for its exclusion I have discussed elsewhere (*Proc Roy Soc Victoria*, xxiv, 1921, p. 22).

It is possible that a further division of one or two of the genera, herein considered, may be necessary. Also it may be necessary in the future, with the discovery of intermediate forms, to unite genera separated on somewhat trivial characters.

Geographical Distribution—The group as a whole occurs throughout the greater part of Australia, but is unrecorded from the North-West and the Northern Territory. Although thus widespread, the group is by far most abundantly represented in Western and South Australia. In the West occur *Euomus*, *Mythites*, *Brachymycterus*, *Dialeptopus*, *Cucullothorax*, *Alexirhea*, *Aedriodes*, *Melanegus*, *Odatesus*, *Ennothus*, *Polycrcta*, *Acherres* and *Amorphorhinus*. With the exception of *Mythites*, *Dialeptopus*, *Acherres* and *Amorphorhinus*, all these genera are peculiar to Western Australia, as are also the two new genera described herein. *Mythites* and *Amorphorhinus* occur throughout the States, the former also extending into Tasmania, *Dialeptopus* and *Acherres* extending into South Australia and the former probably into Victoria. Of the remaining genera, *Bubaris* is mainly eastern, but occurs in South Australia, *Sosytelus* is limited to New South Wales, *Atychoria* is South Australian, and *Tetra-*

lophus is Victorian and South Australian with a possible extension into Western Australia.

This distribution is shown in tabular form below, and the graphic representation brings out the marked preponderance of the genera in Western Australia, fifteen genera out of nineteen being represented in that State, while eleven are peculiar to it. South Australia and New South Wales have each one genus peculiar to the State. Of the remaining two genera not represented from Western Australia, one—*Tetralophus*—possibly does occur there, and the other—*Bubaris*—is eastern, having its headquarters in New South Wales and Queensland. The number of described species known from each State is also indicated on the table. These figures show that species as well as genera preponderate in Western Australia. The eastern distribution of *Mythites* and *Bubaris* is also brought out.

Geographical Distribution of the Genera

Genera	Species	W A	S A	C A	Vic	Tas	NSW	Q
<i>Euomus</i>	4	x (4)						
<i>Euomella</i>	1	x (1)						
<i>Mythites</i>	13	x (1)	x (4)		x (3)	x (1)	x (8)	x (1)
<i>Bubaris</i>	6		x (1)	x (2)	x (1)		x (3)	x (3)
<i>Brachymycterus</i>	1	x (1)						
<i>Dialiptopus</i>	9	x (5)	x (4)		?			
<i>Tetralophus</i>	3	?	x (2)		x (2)			
<i>Cucullothorax</i>	1	x (1)						
<i>Alexirhea</i>	3	x (3)						
<i>Aedriodes</i>	9	x (9)						
<i>Melanops</i>	1	x (1)						
<i>Utychoria</i>	1		x (1)					
<i>Sosyctilus</i>	1						x (1)	
<i>Oditesus</i>	4	x (3)						
<i>Ennothus</i>	1	x (1)						
<i>Polycreta</i>	1	x (1)						
<i>Acherre</i>	5	x (4)	x (1)	x (1)				
<i>Paroditesus</i>	1	x (1)						
<i>Amorphorhinus</i>	6	x (2)	x (2)		x (1)		x (2)	x (2)
Totals Gen	19	15	7	2	4	1	4	3
Species	70	38	15	3	7	1	14	6

EUOMUS

Schönherr. *Mantissa Secunda* Curc. 1847, p. 52, Lacordaire, *Gen. Coleop.*, vi. 1863, p. 316.

Large, elongate, compressed. Head convex, partially concealed, separated from rostrum above by a transverse sulcus, supraocular ridges present. Rostrum short and thick, the upper surface sulcate in the basal portion, the internal ridges present, not cristiform, clypeal plate more or less exerted, not deeply sunken, submentum bisinuate or lobate. Scrobes strongly curved. Antennae short, the scape short and stout, funicular joints short. Eyes ovate, finely faceted. Prothorax strongly transversely convex, rounded on sides, apex strongly produced above, with strong ocular lobes, surface granulate. Elytra elongate, widest at

base or in front of middle, declivous posteriorly, humeral angles very strongly advanced; dorsum foveate, interstices granulate. Prosternum concave in front of anterior coxae. Venter with a boss-like protuberance on each side of the two basal segments, except in *E. scorio*. Legs rather short and stout. Tarsi short and rather broader, the posterior slightly more elongate.

Genotype, *Amycterus insculptus* Bohemann, 1843.

The genus as described above comprises four species, *insculptus*, *stephensi*, *scorio* and a new species. *E. scorio* might, however, be reasonably regarded as generically distinct from the other three species. It differs in having a somewhat longer rostrum with longer internal ridges and a more strongly projecting clypeal plate; the submentum also is strongly lobate, not merely bisinuate, and there are other minor differences.

Euomus was proposed by Schönherr in 1847 for a group of species previously included in *Amycterus*, the following species being included in the genus *insculptus*, *nodipennis*, *scorio*, *westwoodi*, *stephensi*, *basalis* and *fahra*. Of these, *nodipennis* has been placed in *Aedriodes*, *westwoodi* in *Talaurinus*, *basalis* in *Mythites*, *collaris* in *Dialeptopus*, while *fahra* is a *nomen nudum*.

Of the remaining species, *insculptus* was described by Bohemann in 1843; *scorio* by Boisduval in 1835 and *stephensi* by Gyllenhal in 1834.

To these species a fourth, *Euomus retusus*, was added by Pascoe in 1872. I do not, however, consider it congeneric with the other members of the genus and have described a new genus—*Euomella*—to receive it. In the present paper one additional species is proposed as new.

As with so many of the genera of the *Euomides*, the affinities of *Euomus* are not obvious. It is possibly closest to *Mythites*, but differs noticeably in general facies, in the structure of head and rostrum, in the prothorax being strongly produced above the head, and in the elytral sculpture.

With the exception of *E. insculptus*, the different species show a bewildering variability of structure, so great that at first sight it would appear as if several additional species ought to be described. I have preferred, however, to err on the side of caution until, at any rate, more is known of the distribution of the different forms.

Table of species

1 (6) Submentum bisinuate, not lobate	
2 (3) Infra-humeral tubercle absent	<i>E. insculptus</i> Bohem
3 (2) Infra-humeral tubercle present	
4 (5) Elytral granules fine	<i>E. stephensi</i> Gyll
5 (4) Elytral granules large, noduliform	<i>E. nodosus</i> , n. sp.
6 (1) Submentum with strong median lobe	<i>E. scorio</i> Boisd.

EUOMUS INSCULPTUS Bohem

Amycterus insculptus Bohem., Schönh., Gen. Spec. Curc., VII. (1), 1843, p. 56; *Euomus id.*, Schönh., Mantissa Sec. Curr., 1847, p. 53 (reference).

♂ Large, robust, elongate, more or less strongly compressed. Black, densely covered with minute brown sub-squamose pubescence, granules laevigate; setae decumbent black.

Head irregularly set with moderately large, umbilicate setigerous granules, with an oblique, rather indistinct impression on each side of front, supra-ocular margins ridged. Rostrum very short and thick; upper surface slightly depressed, with a short median ridge anteriorly and subparallel ridges at base, extending

back from the end of the median ridge, lateral margins rather strongly convex in profile, outwardly and backwardly divergent. Scrobes strongly curved, open posteriorly. Prothorax strongly convex antero-posteriorly and from side to side; strongly rounded on sides, the disc passing into the lateral surface without interruption, anterior margin strongly produced above head, with strong ocular lobes; disc with a subapical transverse impression well marked towards the sides, a strongly impressed median line, and an irregular, broad, somewhat ill-defined impression on each side anteriorly; upper surface and sides rather closely set with moderately large round granules, varying somewhat in size. Sides with an oblique impression about middle. Elytra elongate, base widely and deeply emarginate, with humeral angles strongly advanced, apices strongly flanged, emarginate and separately mucronate on each side of suture, disc with a series of large open depressions more or less separated from each other, the intervening ridges and the interstices set with small granules very irregularly arranged, but most numerous and in several rows on the interstices, the first, third and fifth interstices slightly raised, wavy in outline, the others hardly traceable as separate interstices. Sides with similar sculpture. Ventral surface flattened, second segment raised on each side into a distinct boss, all the segments and metasternum granulate, in places rugosely so, apical segment with a slight longitudinal depression on each side. Legs stout, femora and tibiae closely granulate, the granules flattened and almost imbricated, tarsi comparatively short.

♀ Very similar to male, somewhat differently shaped, the elytra being more evenly rounded, ventral surface slightly convex at base. *Dimensions*: ♂ 27 x 9 mm, ♀ 27 x 10 mm.

Hab—Western Australia. Perth, Jandakot, Swan River, Champion Bay.

E. maculatus is the largest species of the genus, though occasionally smaller examples may be found. It is also less variable in structure than the other species. The absence of both the infra-humeral and sub-apical tubercles is characteristic, as is also the arrangement of the elytral granules.

EUOMUS STEPHENSI Gyll

Amcyterus stephensi, Gyllenhal, *Schönh. Gen. Spec. Cure*, 11, 1834, p. 473, Boisdual, *Voy. Astrolabe*, 11, 1835, p. 388.

Moderately large. Black, more or less densely clothed with brown sub-squamous pubescence feebly variegated with grey, the clothing in many specimens discoloured or abraded, median ventral vitta present on metasternum and basal abdominal segment.

Head broad, the front rather flattened with moderately numerous small granules, often obsolete, the margins slightly raised in front of eyes. Rostrum short, wide, much as in *E. maculatus*. Prothorax with disc strongly convex from side to side, the median line depressed, free from granules, a semi-lunar depressed area, outwardly convex, present on each side and without granules, the rest of the dorsal surface with moderately large, discrete granules, extending on to the sides. Elytra widest across infra-humeral tubercles, thence gradually narrowed posteriorly, the apex distinctly flanged on either side and shallowly emarginate in the middle, base widely emarginate, the humeral angles strongly produced outwards and forwards into a distinct crest, a small nodule also present at base of third interstice; sculpture of dorsal surface consisting of large open crateriform depressions, arranged more or less in series, but frequently extending across the interstices, the third, fifth and seventh interstices extremely wavy in

outline, almost circinate, lined by small granules frequently extending on to cross-ridges, more or less absent on the obsolete second, fourth and sixth interstices, which are only indicated occasionally by a small granule at the intersection of the cross-ridges, fifth interstices with a nodulose tubercle half-way down declivity and one or two smaller nodules above this, infra-humeral tubercle on seventh interstice present. Ventral surface concave in the middle of the two basal segments and produced on each side into a distinct boss, the remaining segments flattened, the whole surface granulate, somewhat strigose on the basal segments.

♀ Somewhat fuller in shape with basal ventral segments feebly convex. Dimensions ♂ 18 x 7, ♀ 20 x 9 mm. Range from 15 mm to 22 mm. in length.

Hab.—Western Australia

The above description is based on specimens which appear to correspond most closely with the original description, but the series now before me shows striking variations from this which may, perhaps, be regarded as the central form. The variations are often so distinct that one is tempted to regard some of them as specifically different, but the gradations are too many to allow this to be done. Two main types of structure are, however, distinguishable and after prolonged examination and mature consideration, I have thought it advisable to maintain these as specifically distinct, though recognising that one has probably arisen from the other by fusion of separate fine granules into larger nodules.

Under *E. stephensi*, I group all the forms in which the interstices are finely granulate. In this group variation has taken place in the direction of the abasement of the cross reticulations, so that the elytra become broadly sulcate between the first, third, fifth and seventh interstices. Commonly one or two cross-ridges may still appear with one or two granules, generally between the first and third interstices.

A series of specimens from Swan River in the British Museum and others from the same locality in Mr Clark's collection and my own are of this type and are remarkably constant in their structure. In specimens from Capel River and Kelmscott, the sulcate appearance is even more marked, and there is a tendency for the fine granules to become confluent, particularly on the third interstice which appears costate.

A series from Warren River shows variation in another direction, in that the fine granules on the interstices have become obsolete to a greater or less degree, so that the elytra appear practically non-granulate.

It may be that further series will show that in any one locality the structure is more or less constant, the Warren River and Swan River series suggest this, but specimens are not available from a sufficient number of localities and in sufficient numbers to decide.

While the variation is principally in the elytral sculpture, the extent of the granules on the prothorax also shows variation, while variations occur in size and shape.

EUOMUS NODOSUS, n.sp

♂ Closely allied to *E. stephensi* Gyll., but differing in the elytral sculpture.

Head and rostrum as in *E. stephensi*. Prothorax similar to that of *E. stephensi*, but with rather more numerous granules. Elytra set with moderately large, noduliform, nitid tubercles, variable in number and position in the type situated on all the interstices though somewhat larger on the alternate (third, fifth and seventh) ones, in places also present on the cross reticulations, the

tubercles not continuous on the interstices but interrupted, those on adjacent interstices and cross-ridges so situated that a series of transverse lines of tubercles is formed running slightly obliquely upwards and outwards across each elytron, infra-humeral tubercle present, sides with similar tubercles. Ventral surface as in *E. stephensi*, but granules and strigosity less marked. *Dimensions* ♂ 19 x 8 mm

Hab -- Western Australia

Described from one of two specimens in my own collection from an unknown locality

There are before me 10 other specimens in which the elytral sculpture is nodose. These show rather considerable variation *inter se* and from the specimen described above. Most of the specimens are without definite locality and, until long series from known localities are available, it is impossible to regard these variations as entitled even to subspecific rank.

Closely corresponding with the type is a series of four specimens (3 ♂, 1 ♀) without definite locality, in the British Museum collection. The males are slightly smaller and somewhat more attenuate in shape, the nodules are fewer, being absent from the cross reticulations and in places from the intermediate (second and fourth) interstices, the obliquely transverse arrangement is still, however, in evidence. The female agrees closely with the type.

Two females without locality in the South Australian Museum also agree closely with the type, in one the cross arrangement is marked, in the other it is only indicated in places.

All the above agree with the type in having numerous granules on the prothorax. Four specimens before me differ in having fewer granules on the prothorax, there being a wide space between the admedian and lateral groups. The elytral tubercles are fewer than described in the type, and are absent from the fourth and sixth interstices, though present on the second, the transverse arrangement cannot be traced and there is a tendency for the tubercles on the different interstices to be situated alternately.

These four specimens, all of which appear to be males, are from the following localities.—Mt Barker, Mundaring, King River and Serpentine R. From two of these localities, I possess females which apparently belong to *E. stephensi*. A female from Mundaring is quite a typical *E. stephensi* and shows no evidence of nodule-formation. The female from Mt Barker, however, while mainly set with fine granules, does show a tendency for these to coalesce into separate nodules, and might quite justifiably be regarded as the other sex of the Mt Barker male. These Mt Barker specimens raise doubts as to the specific distinctness of *E. nodosus*, but further specimens from this locality will be required before it can be settled as to whether they form a connecting link between *E. nodosus* and *E. stephensi*, or belong to different species. As stated under *E. stephensi*, I believe that *E. nodosus* has become differentiated through a fusion of the fine granules to form separate nodules which are situated at the nodes of intersection of the cross ridges with the interstices.

EUOMUS SCORPIO Boisd

Amycterus scorpio, Boisdual, Voy. Astrolabe, n., 1835, p. 391, Pl. 7, fig. 15. Elongate, narrow, greatly compressed from side to side. Black, clothed with minute grey subequamose pubescence.

Head convex, forehead with granules varying from slightly rugose to

obsolescent. Rostrum longer than in other species, with apical plate more strongly exerted, median ridge absent, internal ridges longer, prolonged farther back. Scape longer and more slender. Prothorax of usual shape in genus, with median and sublateral longitudinal impressions, apex with median and ocular lobes strongly produced, dorsum rather closely set with moderate sized round granules, sides granulate. Elytra elongate, narrow, at humeral angles as wide as or slightly narrower than prothorax, apex rounded feebly flanged, slightly or evidently conjointly mucronate at suture, base strongly emarginate, humeral angles greatly advanced, projecting forwards and outwards. Sculpture of disc variable and irregular, punctures foveiform, inconspicuous, first interstice somewhat raised, except at base, set with fine granules, second, fourth and sixth interstices obsolescent, third raised, wavy in outline, closely set with fine granules, segregated into clumps posteriorly and often fused to form definite tubercles, fifth interstice with fine granules near base, leading into outer border of crest, with isolated tubercles more posteriorly, the last large and constant in position, the others variable in size and number, seventh interstice with irregular granules, infra-humeral tubercle wanting. Lateral interstices irregularly granulate. Ventral surface flattened, with scattered punctures, non-granulate. Tarsi short.

♀ Very similar, ventral surface slightly convex at base, posterior corbels not projecting anteriorly.

Hab—Western Australia. Albany, Swan R., Jandakot, Serpentine R., Mundaring.

This species is extremely variable in size and sculpture, the series before me (23) varies in size from 13 x 4.5 to 18 x 6 mm in the male, and from 15 x 5.5 to 21 x 8 mm in the female. The variations in sculpture are principally in regard to the granulation of the third and fifth interstices. In the least differentiated form the interstices are undulant and finely granulate, the next step appears to be the aggregation of these fine granules into clumps or rosettes, which show a tendency to become separated off, a further step being the elevation of these masses and the fusion of the individual granules. These stages are not, however, sharply marked off from one another, numerous gradations occurring. Commonly the interstices are finely granulate at the base, showing the aggregation process posteriorly. Furthermore, the variation in sculpture seems to have no relation to the size or locality of the specimens.

In the type of the species, now in the National Museum, Paris, the tendency to tubercle formation is well marked.

In the male there is a slight forward projection at the anterior angle of the posterior corbels.

EUOMELLA, n.g.

Size moderate, form elongate, subplanate on dorsal surface, not strongly convex, though moderately deep, strongly declivous posteriorly. Head partially concealed by prothorax, not divided from rostrum above. Rostrum broad, longer than visible portion of head, lateral margins not raised, with two prominent internal ridges at base; apical plate set at extreme apex, exerted. Eyes coarsely faceted. Scrobes curved. Antennae with scape very short, strongly incrassate, funicle with first joint short, second very long, third to sixth short; club ovate. Prothorax angulate-tuberculate on side, produced over head above, with strongly produced ocular lobes almost concealing eyes, disc granulate. Elytra strongly declivous posteriorly, narrow at base, gradually widened to near apex, then suddenly narrowed, apex rounded, base emarginate, the humeral angles ad-

vanced, disc foveate, with alternate interstices tuberculate

Genotype: *Euomus retusus* Pasc

The above genus is formed for the reception of *Euomus retusus* Pascoe. Though allied to *Euomus*, the very different shape of this insect, and the differences in rostrum, eyes, prothorax and elytra render its separation justifiable

EUOMELLA RETUSA Pasc

Euomus retusus Pascoe, Journ Linn Soc, 1872, p 449, t. 13, fig 12

Elongate, narrow Black, densely clothed with brownish subpubescence

Head convex Rostrum moderately long, broad, the upper surface rather shallowly depressed in middle, with two prominent longitudinal ridges running from a little in front of middle to junction with head, these ridges equidistant from midline and lateral margins, lateral margins not raised, curved downwards at base Scape very short Prothorax widest in front of middle, angulate, with a small but prominent tubercle at angulation, apex slightly produced above, ocular lobes partially concealing eyes, disc with a moderately broad median channel with less definite, somewhat irregular, sublateral impressions, the intervening ridge and the sides irregularly set with small rounded granules Elytra gradually widened from base to level of declivity, thence rounded off rather abruptly, declivity almost perpendicular, base emarginate, third and fifth interstices projecting forwards, disc with rows of rather large, somewhat irregular, open, foveiform punctures, third and fifth interstices with rows of small closely set tubercles, granuliform at base, larger posteriorly and ending at declivity, seventh with infra-humeral tubercle, followed by a row of small granules Sides with rows of large punctures, the interstices obsolete granulate Abdomen flat antero-posteriorly, gently transversely convex, closely set with moderately large punctures Posterior tarsi rather short *Dimensions* ♂ 11 x 5 mm.

Hab—Western Australia Champion Bay, Kellerberrin

Described from the type, which appears to be a male, in the British Museum I am indebted to Mr J Clark for a specimen taken at Kellerberrin by Mr. W Crawshaw

MYTHITES

Schönherr, Mantissa secunda fam Curc., 1847, p 11 —*Acanthomus*, Germar, Linn Ent., iii, 1848, p. 210

Size moderate to large, elongate. Head convex, forehead marked with longitudinal and oblique impressions, separated from rostrum by a transverse sulcus. Rostrum short and wide, the upper surface deeply sulcate, with long internal ridges, clypeal plate set rather deeply, submentum straight or dentate in middle, scrobes curved. Antennae with a moderately short, stout scape, funicular joints short. Prothorax more or less strongly rounded on sides; apical margin subtruncate above or feebly rounded, not produced, ocular lobes present, dorsum granulate Elytra elongate, in many species strongly convex and robust, humeral angles produced or rounded, dorsum foveo-punctate; interstices granulate, tuberculate or subcostate Venter flattened in ♂, feebly convex in ♀ Legs rather short, tarsi short, the posterior slightly longer.

Genotype, *Mythites tuberculatus* Lea, designated by Schönherr, but not described

This genus appears to approach most nearly of all the Euomides to the Amycterides vana of Lacordaire, though its immediate affinities are undoubtedly

with the present group. In many respects it would appear to be closest to the archetype of the subfamily.

The generic description is chiefly an enumeration of characters common to many other genera and its claim to generic rank would almost appear to be a lack of the distinctive features such as characterise the other Euomid genera. The deeply set clypeal plate is, however, distinctive and would appear to indicate a relation with *Talaurinus*. The rostrum is constricted at the base, being considerably wider apically. This character separates it from the genus *Bubaris* in which the rostrum is widened posteriorly. From *Euomus* it differs in the rostral sculpture and in not having the prothorax produced above the head, the general shape is also different.

The genus is readily divided into two groups which differ in shape and in the arrangement of the tubercles at the apex of the declivity. In the first subgroup the shape is subcylindrical and robust, in the second there is a distinct tendency towards flattening of the dorsal surface. In the first subgroup the tubercle on the third interstice is placed some little distance above the declivity, whereas in the second there is an oblique line of tubercles across the edge of the declivity on each elytron. I have alluded to these groups as the *tuberculatus* and *asperatus* subgroups. It is possible that these groups should be separated generically and support is lent to this by the geographical distribution. Two other features deserve special mention, in the majority of the species the first and third interstices are distinct at the base, in *basalis* and two other species the two interstices are united. The humeral angles are as a rule advanced in both sexes, in two species these angles are rounded in the female.

The genus *Mythites* was formed by Schonherr (1847) for a species to which he gave the name *M. tuberculatus*, but of which he did not give a description. The species—the only one of the genus known to occur in Tasmania—was many years later described by Lea (1910) under the same name. h sh.

Of the species described prior to 1847 under *Amycterus*, only one—*A. salis* Boisduval (1835)—is referable to the genus *Mythites*. It is rather strange that Schonherr should have referred this species to *Euomus* rather than to *Mythites*.

In 1848, Germar erected the genus *Acanthomus* for two South Australian species—*sulcicollis* and *perfosus*. The synonymy of *Acanthomus* with *Mythites* was pointed out by Lacordaire (1863) who, however, wrongly regarded *tuberculatus* and *sulcicollis* as the same.

Pascoe in 1872 (Ann Nat Hist., pp 84-5) added three species—*asperatus*, *degener* and *pithecus*—to the genus. Subsequently (1882) he removed *pithecus* to *Bubaris*. In the present paper I place *degener* as a synonym of *perfosus* Germar.

In 1910 Lea added 4 species *frater*, *poropteroides* and *foveipennis* (Trans. Roy Soc S Aust., xxxiv), and *granulatus* (Mém Soc entom Belgique, xviii). He also described *M. tuberculatus* (Mitt Zool Mus., Berlin).

In the present paper I have added the names of four new species and of two varieties.

One or two other species, of which I have seen single examples, still await description.

Distribution.—Unlike most of the genera of the group, *Mythites* possesses a wide distribution, from Western Australia to Queensland. One species—*basalis*—is common in Western Australia and extends into South Australia. In the latter State two other species—*sulcicollis* and *degener*—occur, while *tuberculatus*, which is found in Tasmania and Victoria, also extends into South Australia.

Victoria possesses three species—*tuberculatus*, *poropteroides*, and *granulatus*—and Tasmania only one—*tuberculatus*. The above mentioned species, with one exception—*granulatus*—belong to the *tuberculatus* subgroup. In New South Wales eight species occur, only two of which belong to the *tuberculatus* subgroup, the remainder belonging to the *asperatus* subgroup. Queensland has a single representative, described herein and occurring also in N S Wales. It is a member of the second subgroup, the first is, however, represented by at least two undescribed species. The difference in the distribution of the two subgroups is striking—the first coextensive with the range of the genus, the second confined to the eastern side of the continent—and is in itself strong argument for the generic separation of the subgroups.

Table of Species

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|---------|---|----------------------------------|
| 1 (12) | Apical tubercle of third interstice placed well anterior to edge of declivity, comparatively large, robust species | (<i>tuberculatus</i> subgroup). |
| 2 (7) | First and third interstices united at base | |
| 3 (6) | Humeral angles produced in both sexes | |
| 4 (5) | Forehead with four longitudinal ridges, size large | <i>M basalis</i> Boisd |
| 5 (4) | Forehead with a single median ridge, and one above each eye, size small | <i>M perfossus</i> Germar |
| 6 (3) | Humeral angles rounded, at least in female | <i>M poropteroides</i> Lea |
| 7 (2) | First and third interstices separate at base | |
| 8 (11) | Humeral angles produced in both sexes | |
| 9 (10) | Prothorax set with small discrete granules, with a single median sulcus | <i>M sulcicollis</i> Germ |
| 10 (9) | Prothorax with granules fused into large laevigate elevations separated by oblique sulci | <i>M frater</i> Lea |
| 11 (8) | Humeral angles produced in ♂ rounded in ♀ | <i>M tuberculatus</i> Lea |
| 12 (1) | Elytra with an oblique row of tubercles across edge of declivity on each side, more elongate, subplanate species | (<i>asperatus</i> subgroup) |
| 13 (16) | Prothoracic granules fine, regularly disposed forehead with 3 more or less distinct ridges on either side of median line | |
| 14 (15) | Interstices non-granulate | <i>M foveipennis</i> Lea |
| 15 (14) | Interstices finely granulate | <i>M granulatus</i> Lea |
| 16 (13) | Prothoracic granules small, but distinctly larger than in last two species | |
| 17 (18) | Forehead with 4 distinct ridges on each side of median line | <i>M rugosus</i> , n.sp |
| 18 (17) | Forehead with 2, occasionally 3, ridges on each side of median line | |
| 19 (22) | Prothorax regularly granulate, elytral foveae of relatively equal depth | |
| 20 (21) | Interstices somewhat irregular, often broken, distinctly granulate | <i>M asperatus</i> Pasc. |
| 21 (20) | Interstices entire, more regular, obsolete granulate | <i>M montanus</i> , n.sp |
| 22 (19) | Prothorax more rugosely sculptured, elytra with foveae of varying depth, mostly comparatively shallow, with several larger and deeper depressions | |
| 23 (24) | Median line of forehead sulcate, no infra-humeral tubercle | <i>M coxi</i> , n.sp |
| 24 (23) | Median line of forehead carinate an infra-humeral tubercle present | <i>arboricola</i> , n.sp |

MYTHITES BASALIS Boisdual

Amycterus basalis, Boisd, Voy. de l'Astrolabe II, 1835, p. 390 — *Mythites basalis* (Boisd) Lea, Trans Roy Soc S Aust, xxxiv., 1910, p. 24.

Large, robust, subcylindrical. Black, subnitid; with scanty yellowish-brown clothing in depressions.

Head convex; forehead with four longitudinal ridges, separated by narrow

sulci, the median sulcus sometimes reduced. Rostrum moderately long, excavate above, the internal ridges long, prominent, only slightly convergent at base, external margins rather strongly curved downwards at base. Scrobes curved. Antennae with scape moderately long, funicle with first joint longer than the others, the last $\frac{1}{2}$ transverse, club truncate at base. Eyes large, ovate. Prothorax slightly longer than wide, rounded on sides, widest in front of middle, strongly convex. Apical margin somewhat produced above, with well marked though obtuse ocular lobes. Disc with a deep though somewhat irregular anterior transverse impression, a deeply impressed median sulcus, a slightly less marked sub-lateral longitudinal impression and a deep oblique sulcus from transverse impression to base of median line, the median impression bordered by a raised ridge expanded in middle between the anterior and the oblique impressions, the surface of the ridges with setigerous punctures, the rest of the disc between the sulci set with setigero-punctate confluent granules, the outlines of the individual granules often indistinct, a similar mass of confounded granules forming the lateral margin. Elytra elongate, very little widened on sides, widest across anterior ends of the 7th interstice, apex rounded, base with strongly advanced humeral angles, and with a forward projection formed by the conjoined ends of the first and third interstices. Disc with fairly regular rows of open punctures, separated above and below by low ridges and not confluent laterally, second, fourth and sixth interstices low but traceable, first costiform at base and outwardly turned to join base of third interstice, second with a single large tubercle at summit of declivity, third interstice raised, costiform from base to about middle, thence broken into one or two separate tubercles, the apical situated above declivity some distance anterior to tubercle on second interstice, fifth costiform at base, where it arises from humeral crest, and for about a third of its length, thence broken into separate tubercles, the last situated about on same level with last on third interstice, seventh arising abruptly behind and below shoulder in a rather obtuse swollen nodule, followed by a row of somewhat nodose tubercles, lateral interstices with small rounded tubercles, the upper interstices crossed by more or less evident vertical impressions connecting the punctures, these impressions more distinct in some specimens than in others. Ventral surface lightly transversely convex, the individual segments also lightly longitudinally convex, the apical segment more swollen, median vitta brown, extending from metasternum to second visible segment, thence represented by scanty yellow depressed pubescence. Tibiae short and robust, tarsi short.

♀ Resembles male, but broader and more robust, ventral surface convex and without median vitta. *Dimensions* ♂ 15 x 6 mm, ♀ 17 x 7 mm.

Hab—Western Australia. Upper Capel River, Kellerberrin, South Australia.

This species, which appears to be the commonest in Western Australia, has been regarded as that described by Boisduval and corresponds well with his description, though the size given (6 lines) is somewhat smaller.

A number of allied forms also occur in Western Australia and have generally been placed under *basalis*. Two of these forms are here described as constituting distinct varieties or subspecies. Two other specimens before me exhibit variations from the above description, but as these may be individual variations, I have not described them as distinct, merely indicating the points of divergence.

♀ King George Sound. Smaller and narrower, with elytral sculpture more

rugulose, and punctures larger, more open and foveiform and less regular. *Dimensions* 14 x 5 mm.

♀ Swan River. Very large and correspondingly broad, with prothorax wider than long (6 x 7 mm.). Sculpture not differing from usual form. *Dimensions* ♀ 23 x 10 mm. In the typical form the thorax is as wide as long (5 x 5 mm.)

Var. *NODOSUS*, n. var.—♂ Large, robust, black, subnitid, with fine yellowish-brown subpubescence in depressions.

Head with the two median longitudinal ridges partially fused, leaving a central lovea. Rostrum as in typical specimens, except that the internal ridges are somewhat more raised and laevigate. Prothorax slightly transverse, with anterior and sublateral impressions less marked, but the median and oblique sulci well defined, admedian ridges similar but more laevigate, the rest of the surface with rather large, round, discrete, laevigate granules not confounded in groups, except at lateral margin where they are partially fused, sides with discrete granules similar to those on disc. Elytra oblong, comparatively broad, almost parallel-sided, base with humeral angles strongly advanced, first and third interstices conjoined at base and advanced, disc with punctures more open, foveiform, often confluent with those of adjacent series, the depressions extending across and breaking up the interstices, first interstice thickened and out-turned at base to join base of third, second with a single tubercle below summit of declivity, third broken up into a row of large separate tubercles, rounded and nodose at base, more conical towards apex, the last situated above the tubercle on second interstice, fifth interstice with a similar row of a few tubercles ending some distance anteriorly to apical tubercle of third interstice, seventh with a row of somewhat transverse smooth tubercles, extending from a round laevigate infra-humeral tubercle posteriorly to the level of the tubercle on the second interstice, the individual tubercles separated by vertical furrows, extending on to the sides, lateral interstices with smaller nodules. Ventral surface with a median vitta of long ochreous hair extending from metasternum to apical segment of abdomen, the hairs shorter on the last three segments, individual segments convex from before backwards, the apical segment more strongly convex, with a median impression filled by the hairs of the vitta. Legs as in typical specimens of *M. basalis*, but proportionally thicker.

♀ As in ♂, but ventral surface more convex, median vitta thinner, composed of short hairs, not extending on to apical segment. *Dimensions* ♂ 20 x 8.5 mm., ♀ 20 x 9.5 mm.

Hab.—Western Australia. Yalgoo, Cue.

I should have regarded *nodosus* as a good species but for the existence of specimens that seem almost exactly intermediate. Thus a male from Ankertell and a female from Swan River have the prothoracic granules arranged into groups as in *M. basalis*, while the elytral sculpture is similar to *nodosus*, though the tubercles are smaller, particularly on the lateral interstices, the punctures also are smaller and more irregular.

Var. *OBLITERATUS*, n. var. ♀ Large, black, subopaque; with scanty yellow clothing in depressions.

Head and rostrum as in *nodosus*. Prothorax much as in *nodosus*, but the elevations on each side of median line not laevigate, but somewhat fissured, the rest of the surface granulate as in *nodosus*, but the granules slightly depressed and not laevigate. Elytra with regular rows of small foveiform punctures, well

separated from each other and from those of adjacent series, all the interstices traceable in their entirety, little elevated, the third, fifth and seventh more so than the others, first out-turned at base to join third, second with a small tubercle near summit of declivity, third and fifth showing a tendency to break up into separate tubercles, more distinct on the posterior portion of the interstices; seventh with a row of rather low rounded tubercles, extending from a small infra-humeral tubercle, lateral interstices with small granules. Venter convex; no median vitta present, apical segment with a transverse furrow at extreme apex. *Dimensions* ♀ 20 x 9 mm.

Hab—Western Australia

MYTHITES PERFOSSUS Germ.

Acanthomus perfossus, Germar, Linn. Ent., iii, 1848, p. 210—*Mythites degener*, Pascot, Ann. Nat. Hist., 1872, p. 85.

♂ Small, elongate-ovate. Black, with obscure subetose brown pubescence in depressions, ventral surface with a tawny hirsute median vitta.

Head rather strongly convex, separated from rostrum by a transverse groove, forehead with a median ridge bounded by a moderately deep groove on each side, and with a ridge above eyes, ending opposite bifurcation of rostral ridges. Rostrum subcylindrical, narrower than head, upper surface with a deep median sulcus, bounded by a raised ridge on each side, the ridges slightly outwardly curved at each end, feebly bilunate at base, almost rectangular anteriorly, apical plate set slightly in front of anterior ends of ridges. Scrobes looking upward and outwards, rather strongly curved, extending to eyes, but separated by a furrow. Antennae with scape comparatively short and stout, funicular joints small, first slightly elongate, second and third sub-quadrate, fourth, fifth and sixth slightly transverse. Eyes large, ovate, partially concealed by ocular lobes. Prothorax very similar to *M. sulcicollis*, with a deep median groove, the rest of the surface set with small, somewhat obscure granules. Elytra elongate, little widened posteriorly, base with humeral angles moderately strongly produced, and ends of third interstices less strongly so, disc with moderately regular rows of open foveiform punctures, first interstice hardly raised, but out-turned at base to join third interstice, second obsolete, except for a strong conical apical tubercle at edge of declivity, third interstice with granules conjoined to form a low ridge extending from base to beyond middle, and followed by a larger isolated tubercle above declivity, fourth interstice obsolete, fifth interstice represented by a slightly raised, somewhat interrupted ridge, without definite tubercles, not reaching declivity, but produced at base to form the humeral angles. Seventh interstice with a subobsolete infra-humeral tubercle followed by an ill-defined row of granules, ending in two or three rather feeble tubercles. Ventral surface with rather sparse setigerous punctures.

♀ Similar, but more ovate, ventral surface convex without median vitta. *Dimensions* ♂ 10.5 x 4 mm, ♀ 14 x 5.5 mm.

Hab—South Australia. Port Lincoln.

The above description was drawn up from the types of *M. degener* Pasc. in the British Museum. That the species is the same as *Acanthomus perfossus* Germar, I feel certain, after comparing specimens from Port Lincoln with Germar's description.

MYTHITES POROPTEROIDES Lea

Lea, Trans. Roy Soc S Aust, xxxiv, 1910, p. 22

I am indebted to Mr. Lea for an opportunity of inspecting the unique type (♀) of this species

The conjoined anterior ends of the first and third interstices would ally the species to *M. basalis* and *M. perfossus*, but from both it may be separated by the rounded shoulders and the subapical pair of tubercles. These tubercles are situated on each side of the suture, almost touching each other and about two-thirds of the way down the declivity. The apex of the elytra is also very strongly produced.

Hab—Victoria. Geelong

MYTHITES SULCICOLLIS Germ

Acanthomus sulcicollis, Germar, Linn Ent, iii, 1848, p. 211

♂ Moderately large. Black, opaque, with scanty yellowish clothing in depressions, median ventral vitta yellowish-brown.

Head convex, with four longitudinal ridges separated by sulci. Rostrum separated from front by a transverse sulcus, moderately long, the upper surface rather deeply depressed, with moderately prominent internal ridges, the external margins curved downwards at base. Scrobes curved. Antennae with moderately long scape, incrassate, funicle with joints short, the first somewhat larger than the others. Prothorax gently rounded on sides, apical margin slightly produced above, with obtuse ocular lobes, disc with anterior constriction little marked, but with a well defined median impression, bordered on each side anteriorly by a short ridge of conjoined granules, the rest of the surface set with moderately small regular granules. Sides granulate, sometimes with granules obsolete excepting above. Elytra elongate, very gently rounded on sides, base emarginate, with moderately strongly advanced humeral angles, and slight projections at ends of third interstices. Disc with fairly regular rows of comparatively small foveiform punctures, well separated from each other, but the intervening ridges not raised. The second, fourth and sixth interstices not raised, and without tubercles, except for a pair on the second interstices at beginning of the declivity, first interstice costiform at base, not out-turned to join third, third costiform from base to about middle, followed by one or two larger tubercles, the last situated above declivity, fifth interstice with a row of separate tubercles, sometimes with the basal ones conjoined to form a short ridge leading on to humeral crest, the apical tubercle situated anteriorly to apical tubercle of third interstice, seventh with a row of moderately strong separate tubercles. Sides with rather large foveae, interstices not tuberculate nor granulate. Ventral surface with median vitta extending from metasternum to posterior margin of the second visible segment, sometimes extended to reach anterior border of apical segment, the rest of the surface flattened. Anterior tibiae with a subapical fringe of rather dense bristles on under surface.

♀ Similar, but somewhat more produced at apex; elytra with humeral angles equally advanced. *Dimensions*: ♂ 13 x 5 mm, ♀ 15 x 7 mm.

Hab.—South Australia. Adelaide, Mt Lofty, Karoonda, Wirra.

Allied to *M. tuberculatus* Lea, but with humeral angles advanced in both sexes.

MYTHITES TUBERCOLATUS Lea

Lea, Mitt Zool. Mus Berlin, 1910, p. 183.

The rounded shoulders in the female readily separate this sex from the corresponding one of *M. sulcicollis*, in which the shoulders are advanced. The males of the two species are less readily distinguished. In *M. tuberculatus* the prothoracic granules are larger and more irregularly arranged, while the sub-lateral impressions are well marked, the elytra are also as a rule more strongly tuberculate.

A pair in the South Australian Museum differ from the usual form in that the prothoracic sculpture is more as in *M. sulcicollis*. The male, indeed, might well be referred to that species, but the female has the humeral angles rounded. The specimens are from South Australia.

Since *M. tuberculatus* is the only species known from Tasmania, it seems to be certainly that on which Schönherr (*Mantissa Soc. Curc.*, 1847) erected the genus *Mythites*, naming the species, but not giving a specific diagnosis. As, however, a generic description is given and as *tuberculatus* was the only species assigned to the genus, it might be held that the generic description covered the species, in which case *M. tuberculatus* should be cited as of Schönherr and not of Lea.

Hab -- Tasmania, N S Wales, Victoria, South Australia

MYTHITES FRATER Lea.

Lea, Trans Roy Soc. S Aust, xxxiv, 1910, p. 21

A rather strongly laevigate species, in general appearance resembling *M. basalis*, but separated by the first and third interstices not being joined together at base.

From *M. sulcicollis* the prothoracic sculpture will distinguish it, while the strongly advanced humeral angles of the female will separate it from *M. tuberculatus*. It is, moreover, a much more laevigate species than the two latter.

Hab -- North and north-western N S Wales

MYTHITES FOVEIPENNIS Lea

Lea, Trans Roy Soc. S Aust, xxxiv., 1910, p. 23

Specimens of this species have been taken rarely at Blackheath in the Blue Mountains. All the specimens were secured crawling on the ground and there is no evidence that this species frequents vines.

A male in my collection is somewhat smaller than usual, measuring 15 x 5 mm.

Hab N S Wales Blue Mountains

MYTHITES GRANULATUS Lea

Lea, Mém Soc entom. Belgique, xviii, 1910, p. 92

While closely allied to *M. foveipennis*, I agree with Mr Lea in considering it a distinct species. Though represented in most collections, it does not appear to be common.

Hab -- Victoria Melbourne, Monbulk

MYTHITES ASPERATUS Pasc

Pascoc, Ann Nat Hist, (4), x, 1872, p 84

♂ A comparatively small species Black, with scanty brownish clothing in depressions, median ventral vitta black

Head convex, with four ridges separated by a deep median and an oblique impression on each side Rostrum deeply excavate above, the depressed area widest anteriorly, narrow and sulciform at base, internal and lateral ridges equally prominent, the latter somewhat curved downwards at base Scrobes curved Eyes large, ovate, finely faceted Prothorax almost straight-sided, widest behind apex, apical margin hardly produced above, with definite, though obtuse, ocular lobes Disc with anterior constriction moderately well marked, interrupted in middle, median impression little marked, set with small regular round granules, these extending about half-way down sides Elytra elongate, very gently rounded on sides, apex rounded, base emarginate, the humeral angles moderately strongly advanced, the ends of the first and third interstices slightly produced Disc with rows of open foveiform punctures, showing some tendency to become confluent with those of adjacent striae, intra-strial ridges not prominent, interstices granulate, the fourth and sixth practically obsolete, the second with a small tubercle at edge of declivity, the third and fifth more prominent, set with small granules, very irregularly arranged and showing a tendency to grouping, both interstices terminating abruptly above declivity, the end of the third anterior to the tubercle on the second, and the end of the fifth anterior to that of the third, seventh and lateral interstices with small conspicuous granules Ventral surface more or less flattened with rather narrow median vitta

♀ Similar, but larger and more ovate, with the apex somewhat produced, sculpture similar but rougher and with more evident granules on elytra, venter convex, without hirsute vitta. *Dimensions* ♂ 13.5 x 5 mm, ♀ 14 x 6 mm

Hab - N S Wales Sydney

Described from specimens in my own collection The type was, however, seen in the British Museum and the species is certainly correctly identified

The elytral sculpture is much confused and difficult to describe, and this character separates it from the next species, in which the sculpture is much more regular

M asperatus appears to be restricted to the neighbourhood of Sydney, it is now by no means common

MYTHITES MONTANUS, n sp

♂ In size, shape and general facies similar to *M asperatus* Pasc Black, destitute of clothing

Head, rostrum and prothorax similar, the head and rostral ridges somewhat more clearly defined, and prothorax without median impression Elytra with more regular rows of foveiform punctures, with less tendency to transverse fusion of adjacent punctures, second, fourth and sixth interstices low, occasionally interrupted, third and fifth interstices raised, not interrupted, crenulate, setigerous but not granulate, second interstice with a large backwardly directed tubercle overhanging declivity, the third interstice ending anteriorly to second, seventh interstice broken up into a row of obscure granules, much less conspicuous than in *M asperatus* Sides similar to *M asperatus*, but granules less elevated Ventral surface and legs as in *M asperatus*

♀ Shows similar differences from the female of *M. asperatus* *Dimensions.*
♂ 13.5 x 4.5 mm, ♀ 15 x 6 mm

Hab—New South Wales Blue Mountains (Blackheath and Mt Victoria)

This species may be regarded as the Blue Mountain form of *M. asperatus* Pascoe, the differences are noted above

MYTHITES RUGOSUS, n sp

♂ Moderately large, allied to *M. foveipennis* Lea, but with larger granules and deeper elytral foveae. Black, subnitid, clothing absent except for minute brownish squames in the depressions, median vitta brown

Head convex, with a series of longitudinal ridges separated by deep sulci, about four on each side of median line which is depressed. Rostrum comparatively long, thick, separated from head above by a transverse impression; deeply depressed above, with prominent basally convergent internal ridges, external margins prominent, somewhat curved downwards at base. Scrobes curved. Eyes large, somewhat flattened, finely faceted. Antennae with scape moderately long, rather strongly incrassate at apex, funicle with first joint longer than second, the remaining joints short. Prothorax rather feebly rounded on sides, widest in front of middle, anterior margin not produced above, ocular lobes present, obtuse, disc not strongly convex, with a somewhat ill-defined, transverse, sub-apical impression, and moderately well defined median line, set with rather large subnitid granules, varying in size, smallest near the centre, but always distinctly larger than in *M. foveipennis*. Sides granulate. Elytra little widened on sides; apex moderately abruptly rounded, base with well marked, moderately strongly advanced humeral angles, the ends of the first and third interstices slightly advanced. Disc with rows of large deep foveiform punctures, separated by well defined transverse ridges, third, fifth and seventh interstices more raised than the others, which are more or less interrupted by the foveae, second interstice ending in a small conical tubercle above the declivity, third interstice more or less continuous from base to beyond middle, thence broken into obtuse granules or small tubercles, ending in a distinct tubercle situated anteriorly to tubercle on second interstice, fifth interstice broken into a series of small obtuse tubercles, ending in a tubercle anterior to that of third interstice, seventh interstice forming a row of separate nodulose elevations or obtuse tubercles ending posteriorly to tubercles on fifth interstice. Sides with rows of well defined deep punctures, the interstices crossed by a series of vertical ridges extending down from the tubercles of the seventh interstice. Ventral surface with a moderately broad, conspicuous, median, hirsute vitta, the rest of the surface rather sparsely setigeropunctate. Legs simple, tarsi short.

♀ Similar but larger, with more confused elytral sculpture, ventral surface convex with median line clothed with yellowish subpubescence, apical segment with a subquadrate depression at apex. *Dimensions.* ♂ 17 x 6.5 mm.; ♀ 19 x 7.5 mm

Hab—N.S. Wales Boro (W. W. Froggatt), Weddin Mts. (T. G. Sloane), Portland (E. W. Ferguson)

The holotype ♂ was taken at Boro in March, 1894, while the autotype female was found by Mr Sloane some years ago on the top of the Weddin Mountains, near Grenfell. The Portland specimen is a male and is smaller (16 x 5.5 mm.) though otherwise agreeing with the Boro male.

The elytral sculpture is much confused; the strong development of the ridges

separating the deep foveae above and below, with the interruption of the interstices opposite the foveae, has led to the development of a series of transverse rugae, most marked in the outer portion of the elytra and on the sides

MYTHITES ARBORICOLA, n sp

♀ Moderately large, elongate Black, rather densely clothed with minute grey and metallic coppery subpubescence, the grey forming three vittae on prothorax, and scattered macules on elytra.

Head convex, forehead depressed, somewhat rugulose, with median line carinate, and with lateral margins raised, ridge-like, above the eyes. Rostrum separated from head by a deep transverse sulcus, rather short and wide, the upper surface deeply depressed, internal ridges short, convergent to base, external margins equally raised, subangulate in front, curved downwards at base. Scrobes curved. Antennae with scape moderately long, funicle with joints short, the first two longer than the others, club somewhat elongate. Prothorax little rounded on sides, apical margin truncate above, with obtuse ocular lobes, disc with a distinctly impressed median line, the anterior transverse impression represented by a somewhat irregular depressed area on each side, with another irregular, though deep, depression corresponding in position to the oblique sulcus of other species, surface set with moderate-sized round granules, slightly depressed, not confluent and extending on to and covering sides. Elytra elongate, gently rounded on sides, apex somewhat produced and separately mucronate, base emarginate, with advanced, somewhat noduliform humeral angles, the ends of the first and second interstices projecting forwards to a less extent. Disc with irregular, ill-defined, open, foveiform punctures, the first, third, fifth and seventh interstices with small distinct granules in double series, sometimes present also on the intervening areas, second interstice with a prominent tubercle at summit of declivity, diverging from its fellow on the opposite elytron, the third and fifth interstices each with a similar tubercle, that on fifth strongly outwardly projecting, the three tubercles set in an oblique line across each elytron, seventh interstice with a moderately well defined infra-humeral tubercle, lateral interstices with granules obsolete. Ventral surface convex, no median vitta, the surface with numerous small golden-brown maculae. Dimensions ♀ 17 x 6 mm.

Hab—Queensland Mt. Tambourine (H J Carter), N S Wales Glen Innes (H W Brown)

The Mt Tambourine specimens, two in number, were shaken by Mr Carter from vines. Mr Brown informs me that he obtained his specimen on the ground.

Apart from the following species, *M. arboricola* is most nearly allied to *M. foveipennis* and *M. granulatus*, but the sculpture is rougher than in these two species, while the individual granules are smaller than in *M. rugosus*. The prothoracic sculpture also differs from that in those species.

MYTHITES COXI, n sp

♀ Closely allied to *M. arboricola*, but somewhat differently sculptured. Black; with sparse dark brown clothing.

Head convex with deeply impressed median line and shorter sublateral impressions separating four rounded somewhat ill-defined ridges. Rostrum much as in *M. arboricola*, the internal ridges rather more prominent. Prothorax rather broader, little rounded on the sides, with rather feebly impressed median line and

indistinct impressions on the disc, surface set with round granules, somewhat depressed and varying in size. Elytra rather broader than in *M. arboricola*, the outline of the sides less crenulate, base more evenly emarginate, the humeral angles advanced, but the ends of the third interstices hardly produced, disc with sculpture more regular, the depressions less marked, and the interstices less crenulate, the tubercles at apex of second, third and fifth interstices decidedly smaller, particularly that on fifth interstice, while the tubercle on the second is more approximated to the one on the opposite elytron, seventh interstice not arising from a definite intra-humeral tubercle, and composed of low irregular granules rather than tubercles. Ventral surface almost destitute of clothing. *Dimensions* ♀ 17 x 6.5 mm

Hab — NS Wales. Eccleston (Allyn R.), Bulahdelah

After some hesitation I have decided to describe this species as distinct, rather than as a variety of *M. arboricola*. The differences are obvious to the eye, but more difficult to define, on the whole it may be said that *M. arboricola* is the more irregularly sculptured insect of the two. Also the differences in the forehead, if constant, as in the specimens available, afford a ready means of differentiating the two species, in *M. arboricola* the median line is carinate, in *M. coxi* it is sulcate.

The type was taken near Eccleston on the Allyn River (a branch of the Paterson) clinging to a vine in the scrub. A second female was taken in the same locality by Mr J Hopson. The third specimen is somewhat larger (19 x 7.5 mm) and was captured by the late H. W. Cox some years ago at Bulahdelah, also in a vine. I have affixed Mr Cox's name to the species in commemoration of his services to entomology.

BUBARIS

Pascoe, Ann Mag Nat Hist, (5), ix, 1882, p. 378

Small, ovate. Head convex, separated from rostrum by a transverse sulcus. Rostrum short and broad, the upper surface sulcate, with conspicuous internal ridges, the lateral margins out-turned at base, clypeal plate exerted, submental margin convex or dentate in middle. Scrobes strongly curved downwards, almost reaching eyes. Antennal scape moderately short, strongly incrassate and dilated at apex, funicular joints short. Prothorax rounded on sides, apical margin slightly produced above, with well-marked ocular lobes, dorsum granulate. Elytra gradually widened posteriorly to level of declivity, thence suddenly contracted to apex, declivity abrupt, humeral angles produced, dorsum more or less regularly punctured, interstices granulate. Prosternum not excavate. Legs comparatively short, tarsi short.

Genotype, *B. indennis* Pascoe

In describing the genus Pascoe referred to it as having somewhat negative characters. On the whole, however, the species comprised in *Bubaris* form a fairly homogeneous group, whose affinities would appear to be both with *Mythites* and *Aedriodes*. From the former, *Bubaris* differs in its general form and in the rather shorter rostrum expanded and not narrowed at base, with definitely exerted clypeal plate. The rostral structure also separates it from *Aedriodes*. In the majority of the species the expanded scape is characteristic. *Brachymycterus* is closely allied in many respects, but is without ocular lobes.

The genus was founded in 1882 by Pascoe for *B. indennis*, at the same time *Mythites pithecius* Pascoe (1872) was referred to the genus.

In 1910 Lea added the names of 3 species—*hardcastlei* (Trans Roy Soc S Aust, xxxiv, p 20), *apicalis* and *pubescens* (Mem Soc. ent Belgique, xviii, pp. 90-91). One of these however—*apicalis*—is synonymous with *B indemnis* Pasc.

In the present paper one new species is added and one—*rudis* Blackb—transferred from *Atychoria*. This species presents several differences, however, from the other species and may eventually require a new genus. The genus *Bubaris* is practically confined to the inland districts of New South Wales and Queensland, *B pithecius* is widely distributed in New South Wales and *B indemnis* in the northern portion of the central division of Queensland extending to the coastal districts at Mackay, Bowen (Port Denison) and Townsville, Lea also records it from as far south as Brisbane. *B carteri* appears confined to the tablelands of northern New South Wales and southern Queensland. *B hardcastlei* occurs in the south-western districts of Queensland, while *B pubescens* has a wide range in western New South Wales extending to Cooper's Creek. *B rudis* Blackb is from Central Australia.

Table of Species

1 (8)	Elytra with a row of tubercles across declivity	
2 (3)	Elytral sculpture nodulo-tuberculate	<i>B pithecius</i> Pasc
3 (2)	Elytral sculpture granulate (the subapical tubercles excepted)	
4 (7)	Clothing short	
5 (6)	Elytral punctures normal, interstices with small granules	
		<i>B indemnis</i> Pasc
6 (5)	Elytral punctures narrow, elongate, interstices with minute granules	
		<i>B carteri</i> , n sp
7 (4)	Clothing long pubescent	<i>B pubescens</i> Lea
8 (1)	Elytra without tubercles across declivity	
9 (10)	Scape strongly dilatate	<i>B hardcastlei</i> Lea
10 (9)	Scape incrassate but not dilatate	<i>B (?) rudis</i> Blackb

BUBARIS PITHECIUS Pascoe

Mythites pithecius, Pascoe, Ann Nat Hist, 1872, p 84 - *Bubaris pithecius*, Pascoe, op cit, 1882, p 378 (reference), id, Lea, Mém Soc ent Belgique, xviii, 1910, p 89

♂ Black, practically destitute of clothing, nigro-setose

Head convex, rather rugosely granulate. Rostrum separated from head above by a transverse sulcus, upper surface with median line deeply impressed, internal ridges prominent, external margins curved outwards and somewhat downwards at base. Scrobes curved, extending back to eyes. Scape of antennae moderately short, strongly incrassate, first joint of funicle longer than wide, the others briefly transverse. Prothorax feebly rounded on the sides, the apical margin produced above, with feeble post-ocular lobes, dorsum deeply impressed in median line, and with somewhat irregular sublateral impressions, the surface set with round granules showing a more or less well marked tendency to fuse into longitudinal ridges on each side of the median impression, the granules larger near the sides, lateral surfaces granulate above, punctate beneath. Elytra elongate, gradually widened to level of declivity, thence suddenly rounded, base with humeral angles advanced, also to a less extent the ends of the third interstices, dorsum with four tubercles across the declivity, situated on the second and fourth interstices, the inner pair the larger, punctures shallow, open, not very distinct, third and fifth interstices raised, set with somewhat obsolete, more or less fused

granules, in irregular series; lateral interstices with more distinct granules. Ventral surface flattened, with small, inconspicuous setigerous punctures. Anterior tibiae hirsute along inner border.

♀ Similar but broader, the ventral surface feebly convex. *Dimensions.* ♂. 11 x 4.5, ♀ 11 x 5.5 mm.

Hab—N. S. Wales. Monaro, Goulburn, Grenfell, Victoria.

A rather common and widely distributed species showing some variation in the development and distinctness of the granules. In two specimens (♂ and ♀) from an unknown locality, the elytral granules on the third and fifth interstices are fused to form distinct, somewhat wavy costae.

BUBARIS INDEMNIS Pascoe

Pascoe, Ann Mag Nat. Hist. (5), ix, 1882, p. 378.—*B. apicalis* Lea, Mém. Soc. entom. Belgique, xviii, 1910, p. 90.

I have examined the type of *B. indemnus* Pasc., in the British Museum, and it is certainly conspecific with *B. apicalis* Lea.

The species is to some extent variable in the degree of granularity of the elytra, but the differences hardly appear to be of specific value. *B. indemnus* has a wide distribution in Queensland.

Hab—Brisbane, Wide Bay, Rockhampton, Mackenzie River, Peak Downs, Mackay, Port Denison (Bowen), Townsville.

BUBARIS CARTERI, n.sp.

♂ Small. Black, moderately densely clothed with minute black subpubescence.

Head convex, forehead with obscure flattened granules. Rostrum short, thick, not separated from head above, upper surface with median line deeply impressed, internal ridges moderately prominent, rather feebly convergent towards base, lateral ridges not angulate anteriorly, curved outwards at base. Scrobes curved. Antennae with scape greatly dilated at extremity, funicle with joints short, the first and second more elongate than the remainder which are transverse; club with base truncate, closely applied to funicle. Prothorax somewhat feebly rounded on sides, widest in front of middle, apical margin rather strongly advanced over head, with feeble ocular lobes, disc with well marked, deeply impressed median line, and with a second impression midway between median line and lateral margin, deep anteriorly, fading away on posterior half, the derm between these impressions set with small obscure granules, showing a tendency to become strigiform. Sides granulate. Elytra elongate, gradually widened to level of declivity, thence rather suddenly rounded, base emarginate, with humeral angles produced, the ends of the third interstices also advanced; disc very strongly declivous posteriorly, with a row of 4 small obtuse tubercles across edge, these being situated on the third and fifth interstices, the two inner striae with narrow elongate cleft-like punctures often confluent, the more lateral striae with fewer similar punctures, interstices feebly raised, with minute setigerous granules, difficult to trace. Sides with more rounded punctures, the interstices not granulate. Ventral surface flattened, with deep sutures between the intermediate segments, metasternum and ventral segments with moderately large deep punctures, irregularly arranged on basal segments, set in a row along the posterior border of the intermediate segments. Legs short, posterior tarsi short.

♀. Similar, prothoracic granules more distinct; ventral surface very feebly convex at base, with sutures slightly less depressed *Dimensions* ♂ 8.5 x 4 mm.; ♀ 9 x 4.5 mm

Hab—Queensland Dalveen (H J Carter, Dec, 1910); NS Wales Upper Clarence River (H J. Carter, Sept, 1904), Glen Innes (H. W. Brown)

A small rather dingy species, with curious narrow elongate elytral punctures

BUBARIS PUBESCENS Lea

Lea, Mém Soc entom. Belgique, xviii, 1910, p 91.

This species is readily distinguished from its congeners by the nature of the clothing It is widely dispersed in western NS Wales, extending into Central Australia

Hab—NS Wales Bourke, Wilcannia, Coolabah, Nevertire, Narromine, Moree, Central Australia Cooper's Creek

BUBARIS HARDCASTLEI Lea

Lea, Trans Roy Soc S Aust, xxxiv, 1910, p 20

This distinct species differs from all others, with the exception of the following, which is somewhat doubtfully referred to the genus, in lacking the larger tubercles across the summit of the declivity of the elytra I am indebted to Mr Lea for a paratype of the species

Hab—Queensland

BUBARIS RUDIS Blackb

Atychoria rudis Blackburn, Report Horn Exped Cent Aust, ii, 1896, p 294.

Elongate, subcylindrical Black, almost destitute of clothing, a few yellow or grey patches of subpubescence about declivity and sides

Head strongly convex, separated from rostrum by a transverse impression, irregularly granulate behind transverse impression. Rostrum short and broad, dorsal surface with a deep median sulcus, bordered on each side by a raised ridge, with a longitudinal impression between ridge and external margin, the latter outwardly and backwardly directed in basal portion Scrobe curved, not reaching eye Scape short and thick Eyes flattened, almost concealed by ocular lobes Prothorax evenly rounded on sides, very strongly transversely convex, apical margin with strong ocular lobes, disc with well-marked subapical transverse impression, median line not impressed, set with rather large, umbilicate non-contiguous granules, sides similarly granulate Elytra elongate, very little widened posteriorly; base emarginate, the ends of the third and fifth interstices projecting forwards, disc strongly convex from side to side, with moderately deep, open punctures; interstices all equally prominent, set with moderately large umbilicate setigerous granules, frequently duplicated, giving a very confused appearance to elytra. Sides with similar but less evidently umbilicate granules Ventral surface with a median black hirsute vitta on basal half, intermediate segments subnitid with a few setigerous punctures; apical segment with a few coarser punctures at apex. Tarsi short and broad. *Dimensions* ♂ ♀ Long, 4-5; 1; Lat 1 3/5-2 3/5 1 (Blackburn)

Hab.—Central Australia Storm Creek, Tempe Downs, Tareoola

I have examined the type of the species, now in the British Museum, as well as a paratype and another specimen in the South Australian Museum. The species cannot be allowed to remain in *Atychoria*, but I am doubtful of its exact position. Possibly a new genus should have been erected to receive it, but I have thought it better to place it, at least tentatively, in *Bubaris*. The chief objections to its inclusion in *Bubaris* are its more elongate subcylindrical form and the non-dilatate scape.

BRACHYMYCTERUS

Ferguson, Trans Roy Soc S Aust, xxxix, 1915, p 87

The following particulars should be added to the generic diagnosis. Rostrum rather wider at base than apex, clypeal plate slightly exserted, submentum lobate, eyes coarsely faceted.

The genus is undoubtedly allied to *Bubaris*, but distinct, being readily separated by the absence of prothoracic ocular lobes as well as by the lobate submentum and differences in the rostrum.

BRACHYMYCTERUS AURITUS Ferg

Ferguson, *loc cit*, p 88

Hab.—Western Australia. Cue

AEDRIODES

Pascoe, Ann Nat Hist, (4), x, 1872, p 85

Small, elongate or comparatively broad. Head convex, slightly flattened in front. Rostrum short and broad, flattened above, in the same plane as the front of head, median line sulcate, internal ridges broad and flattened, hardly differentiated externally from the rest of the surface, clypeal plate situated on upper surface, hardly projecting, but separated by a deep V-shaped sulcus. Scrobes short, straight or slightly curved. Antennae short. Submentum feebly bisinuate. Prothorax convex, rounded on sides, apex feebly produced above; ocular lobes present, feeble and obtuse, dorsum with deep median sulcus and sublateral sulci in anterior portion, surface granulate. Elytra either relatively broad or more elongate, humeral angles produced; disc with fairly regular punctures, interstices granulate, tuberculate or subcostate. Prosternum not excavate. Legs moderately long, tarsi short, the posterior slightly longer.

Genotype, *Ae fastigatus* Pascoe

The rostral structure affords the most distinctive character of this genus, the subplanate dorsum with narrow impressed median line and flattened internal ridges, and the position of the clypeal plate are very characteristic. The prothoracic sculpture shows an approach to *Bubaris*, and to a less extent to some of the other genera. The elytra show the usual two rows of tubercles, the humeral angles are well marked and advanced, sometimes markedly so.

The genus was established in 1872 by Pascoe for the reception of 3 species—*fastigatus*, *mendocinus* and *inuus*, and the first of these is here designated as genotype. At the same time Pascoe referred *Euomus nodipennis* Bohem (1843), originally described as an *Amycterus*, to *Aedriodes*. This species was among those referred by Schonherr to *Euomus* when that genus was described in 1847.

In 1903, Lea added a fifth species—*humeralis*—to the genus. In the present paper 4 additional species are proposed as new.

As in many other genera of the Euomides, the species are often ill-defined and it is difficult to differentiate satisfactorily between them. In some instances they may represent geographical races or subspecies. It is easy for instance to separate specimens of *Ae nodipennis* from the Geraldton district from specimens of *Ae fastigatus* from King George Sound, but specimens from Swan River, the type locality of *Ae nodipennis*, are almost exactly intermediate between the other two.

The genus as a whole falls into two groups, the one comprising somewhat larger, and distinctly broader species, the other more elongate and narrow species.

Aedriodes appears restricted to the south-western corner of Western Australia, extending from King George Sound as far north as Geraldton and inland to Kellerberrin.

Table of Species

- | | | |
|---------|---|-----------------------------|
| 1 (6) | Form broad, robust, comparatively large | |
| 2 (5) | Elytral punctures small | |
| 3 (4) | Humeral angles strongly produced outwards as well as forwards | |
| 4 (3) | Humeral angles advanced, but less strongly outwardly directed | <i>Ae fastigatus</i> Pasc |
| 5 (2) | Elytral punctures distinctly larger | <i>Ae nodipennis</i> Boh |
| 6 (1) | Form narrow, elongate | <i>Ae foveolatus</i> , n sp |
| 7 (8) | Elytral interstices subcostate | |
| 8 (7) | Elytral interstices tuberculate or granulate | <i>Ae. humeralis</i> Lea. |
| 9 (10) | Apices of elytra produced, conjointly mucronate | <i>Ae mucronatus</i> , n sp |
| 10 (9) | Apices of elytra rounded, not conjointly mucronate | |
| 11 (16) | Anterior tibiae with a dense hirsute subapical brush on under and inner sides | |
| 12 (13) | Elytral tubercles comparatively large and conical | <i>Ae mendosus</i> Pasc. |
| 13 (12) | Elytral tubercles small or more obtuse | |
| 14 (15) | Size moderate (10 mm), sculpture somewhat confused | <i>Ae tibialis</i> , n sp |
| 15 (14) | Size small (8 mm) sculpture regular | <i>Ae crawshawi</i> , n sp |
| 16 (11) | Anterior tibiae longer with less definite brush | <i>Ae inuus</i> Pasc |

AEDRIODES FASTIGATUS Pasc

Pascoe, Ann Nat Hist, 1872, p 86, t 1, fig 8

Broad, robust. Black, almost destitute of clothing, a few minute whitish squames on elytra, and a few small maculae on the sides, head with a patch of brownish squames.

Head convex. Rostrum with basal ridges wide, flattened, hardly at all raised. Scape short and thick. Prothorax widest in front of middle, with a deep median impression, deepest in anterior half, and with a shorter deep sulcus on either side of apex, disc strongly convex, closely set with round flattened granules, as it were tessellated. Elytra with subparallel sides; humeral angles marked by a strongly projecting crest, seriate punctures very small, almost obsolete, in irregular lines, interstices, with the exception of the third and fifth, not raised or granulate, third interstice incurved at base and towards declivity, from base to middle of elytra forming a strongly raised ridge, projecting anteriorly, with a single large truncate tubercle posteriorly; fifth interstice with a large outwardly and forwardly projecting humeral crest, followed by 3 tubercles, the apical one the largest. Sides with moderately large punctures, the interstices not granulate. Under surface feebly convex in basal portion with scattered setigerous punctures, apical

segment with a shallow median impression at apex. Posterior tarsi with basal joint of moderate length *Dimensions*. Long 5 lin. (Pascoe)

Hab—Western Australia Albany

This species is closely allied to *As nodipennis* Boh and may represent the southern form of that species. It differs principally in the greater development of the humeral crests and elytral ridges and tubercles. The punctures are also smaller and less numerous, though the actual number in a stria varies in different specimens. The prothoracic granules are also somewhat flattened.

AEDRIODES NODIPENNIS Bohem

Amycterus nodipennis Bohemann, *Schönh Gen Cure*, vii, (1), 1843, p 68.—*Euomus id*, *Schönherr, Mant Secund*, 1847, p 54.—*Aedriodes id*, *Pascoe, Ann Nat Hist*, iv, 10, 1872, p 85

Small, broad, robust. Black, often destitute of clothing, in fresh specimens sparsely clothed with minute decumbent subsquamose pubescence varying from white to copper in colour, with patches of larger white or yellow squames near lateral border and on sides of elytra and sometimes on the declivity.

Head convex. Rostrum short, rather wider at base than at apex, moderately deeply impressed in the middle line, internal ridges hardly traceable, clypeal plate with raised margins extending basally as a median carina for a short distance. Submentum sinuate. Scrobes rather feebly curved. Antennae with short scape, funicular joints all short. Eyes subrotundate. Prothorax rounded on sides, with feeble ocular lobes, disc convex with a median and two sublateral foveiform sulci anteriorly; set with round discrete granules fused to form a ridge between the median and sublateral impressions; sides granulate above. Elytra ovate, comparatively broad, base emarginate, with humeral angles advanced and cristiform, the ends of the third interstices also advanced, dorsum with rows of moderately distinct punctures, third interstice raised into a rather low but distinct ridge extending backwards and somewhat outwards, ending about middle, and followed by a separate larger tubercle in front of declivity; fifth interstice slightly raised from base of humeral crest to about middle, followed by two or three rather small conical tubercles, the apical the largest and situated on the upper portion of the declivity. Sides with rather deep punctures, the interstices obsolete granulate. Ventral surface flattened, with a small apical depression. Legs normal, anterior tibiae without a distinct brush; posterior tibiae with apical spur.

♀ Larger and broader, venter feebly convex, posterior tibiae without spur. *Dimensions* ♂ 10 x 4 mm, ♀ 11 x 5 mm

Hab—Western Australia Swan River District

The species described above appears undoubtedly to be the one described by Bohemann and from the same locality. Most of the specimens are simply labelled Swan River, others bear labels from S Perth, Parkerville, Jandakot, and Gingin, in the same district.

At first sight these Swan River specimens would appear to belong to *As. fastigatus* and the species are undoubtedly closely allied, if not merely geographical races, the differences are discussed under *As fastigatus*.

Though I believe the name *nodipennis* to be correctly applied to these specimens, it has been more generally affixed to a slightly different form from farther

north; thus I propose to regard as a variety rather than as a distinct species, I append a description but do not propose a separate name.

Var ♂ More densely clothed with minute pubescence, generally coppery or yellowish in colour. Head, rostrum and prothorax similar to *Ae. nodipennis*. Elytra very slightly rugulose between the punctures, third interstice with distinct rounded granules, close together at base but not fused and continued on to apical tubercle practically without interruption, fifth interstice with round tubercles throughout its length, larger posteriorly and extending as one or two small spicules farther down declivity. *Dimensions* ♂ 9 x 4 mm, ♀ 10-12 x 4.5-6 mm.

Hab—Western Australia Geraldton, Cottesloe

AEDRIODES FOVEOLATUS, n.sp

Comparatively large, closely allied to *A. fastigatus* but with larger foveiform punctures. Black, subnitid, without clothing.

Head, rostrum and prothorax as in *A. fastigatus*. Elytra broad, base with humeral angles strongly produced into a forwardly projecting crest, disc with rows of moderately deep foveiform punctures, smaller and becoming obsolete on declivity; granules absent, third interstice somewhat incurved at base and projecting forwards, with a short row of small, conjoined tubercles ending in a larger conical tubercle about middle, and followed by a large isolated conical tubercle above declivity, fifth interstice with humeral crest projecting strongly forward and but little outward, with two or three small obtuse tubercles followed by one or two larger acutely conical tubercles on sides of declivity; sides with large, foveiform punctures. Under surface feebly convex at base of abdomen, with a large fovea at apex. Anterior tibiae not hirsute beneath. *Dimensions* 11.5 x 5 mm.

Hab—Western Australia Kellerberrin (W Crawshaw), Beverley (E F Du Boulay).

Described from four males, two from each locality. The species is closely allied to *Ae. fastigatus* and should perhaps be regarded as a geographical subspecies, but for the fact that there is a typical specimen of *Ae. fastigatus* before me from Kellerberrin. Possibly further collecting will tend to link up the two species.

Ae. foveolatus, in addition to the more evident punctures, differs from *Ae. fastigatus* in the structure of the basal portion of the third interstice, the number of tubercles on the interstice is however variable, and fusion would convert the interstice into a ridge as in *Ae. fastigatus*. The number of punctures in the striae is variable.

Type in author's collection, paratypes in Mr Clark's collection and in the South Australian Museum.

AEDRIODES HUMERALIS Lea.

Lea, Trans. Roy. Soc. S. Aust., xxvii, 1903, p. 113.

This species can be readily distinguished by the characters of the third and fifth elytral interstices which are raised and subcostiform. The raised portion of the third interstice ends in a tubercle beyond the middle of the elytron, which tubercle is followed by a larger one above the declivity. The fifth interstice is almost uninterrupted from the base to the terminal tubercle which is situated slightly anterior to the large tubercle on the third interstice, both interstices are

finely granulate The scape appears to be short The anterior tibiae are moderately strongly clothed with setose hairs, these, however, not forming a dense brush

The type, for the opportunity of inspecting which I am indebted to Mr. Lea, appears to be a male

Hab—Western Australia Mt. Barker

AEDRIODES MUCRONATUS, n sp

Elongate, narrow, with apex strongly mucronate Black, very sparsely clothed with exceedingly minute brownish squames

Head and rostrum as in *A. inuus*, but scape shorter and more incrassate Prothorax similar, but granules less depressed Elytra elongate, apex strongly produced and conjointly mucronate, disc with closely set rather obscure punctures, interstices with small obscure granules, third interstice incurved at base and towards declivity, projecting strongly forward at base, with a conjoined row of setigero-punctate granules or low tubercles to middle, followed by two or three larger multipunctate tubercles, the last and longest situated above the declivity, fifth interstice with a strong forwardly projecting humeral crest bordered by a row of granules, and followed on the interstice by a row of four tubercles, on one side preceded by a few granules, the tubercles multipunctate, becoming larger posteriorly and ending on a level with the apical tubercle of the first row, seventh interstice visible from above, with small obsolete granules Sides with regular rows of small punctures, the interstices not granulate Ventral surface flattened at base Prosternum with a prominent median tubercle behind the anterior coxae Legs rather slender, the anterior tibiae moderately strongly hirsute beneath *Dimensions* 10.5 x 4 mm

Hab—Western Australia Mundaring (J. Clark)

There are 5 specimens before me which appear to constitute a species distinct from any described species of *Aedriodes*, unfortunately all appear to be females

The species is perhaps closest to *Ae. mendosus*, but differs in the produced, conjointly mucronate apex of the elytra, and in the distinctly less elevated, obtuse pluripunctate tubercles The prosternal tubercle is also larger The male will probably be found to possess hirsute anterior tibiae

AEDRIODES INUUS Pasc

Pascoe, Ann Nat Hist, 1872, p. 86

♂ Elongate, narrow Black, destitute of clothing

Head rather strongly convex, as viewed from the side, forming a continuous curve with dorsal surface of rostrum and not separated by a marked sulcus. Rostrum very short, wider at base than at apex, forming a subtruncate cone, upper surface with apical plate somewhat raised, bordered by raised margins, these subtended by a depressed sulcus, the basal portion of the dorsal surface with two rather broad raised flattened ridges, parallel, separated by a deep median sulcus Scrobes opening upwards and outwards, rather strongly curved. Scape moderately short and stout, not greatly incrassate Prothorax moderately strongly and evenly rounded on sides, apex slightly produced, ocular lobes present; disc transversely convex, with a deep median depression in anterior half, thence shallowly impressed, with a smaller one on each side at apex; closely set with

moderately small round contiguous granules. Elytra elongate, gradually widened to about level of declivity, thence narrowed to apex, base with the ends of the third and fifth interstices projecting forwards, the latter forming the humeral projection, disc with rows of small punctures, not granulate between, second interstice with a few almost obsolete granules, third slightly incurved at base, with a row of tubercles, the basal ones small, granuliform, joined to form a short low ridge, followed by 3 separate tubercles, the last the largest, conical, projecting back over the declivity, fifth projecting forwards at humeral angle, the projection lined by a row of fine granules on outer edge, then with a row of about 4 tubercles, the basal two small, the apical two large and conical. Sides rather coarsely punctate, almost cancellate, the intervening ridges somewhat raised, not granulate. Legs moderately long and thin, hind tarsi with basal joint moderately elongate. Under surface flat, apical segment with a median oval apical impression.

♀ Generally larger and somewhat more ovate, posterior tibiae without apical spur. *Dimensions* Long 4.5 lin (Pascoe).

Hab—Western Australia. King George Sound, Beverley, Parkerville, Ludlow.

Ae. inuus is perhaps the commonest species of the genus and a fair number are available for comparison. These show that the species is to some extent variable in the number and development of the tubercles and in size. Several forms have been included under *Ae. inuus* which appear to be specifically distinct, and I have described three new species in the present paper which are more or less closely related to *Ae. inuus*.

The elytral tubercles, though moderately large, are less acute than in *Ae. mendosus*, and granules are absent or only obsolete on the intermediate interstices, while the anterior tibiae though set with moderately dense bristles do not have the bristles arranged in a very distinct brush, though in one or two of the series before me there is some tendency to the formation of the brush. As in these specimens, which are typical, the anterior tibiae are also slightly longer and thinner, it is possible that more than one species are still confused under this name.

AEDRIODES TIBIALIS, n. sp.

♂ Of size and general facies of *Ae. inuus* Pasc., but differing in the clothing of the anterior tibiae. Black, head densely clothed with pale golden, appressed, subsquamose pubescence, prothorax and elytra moderately densely clothed with grey.

Head and rostrum as in *Ae. inuus*. Prothorax similar. Elytra similar in shape and general appearance, the apex rounded, not mucronate, sculpture of dorsum somewhat more rugose, the intermediate interstices granulate, second interstice with a row of low obtuse tubercles, hardly more than granules, ending before declivity, third with similar tubercles, slightly larger, culminating in a moderately large tubercle on edge of declivity, fifth interstice with humeral crest projecting forwards much as in *Ae. inuus*, followed by a row of about 5 tubercles, rounded and obtuse, the last 3 distinctly larger and the terminal one large, similar to the apical tubercle of third interstice and situated anterior to it, lateral interstices granulate. No prosternal tubercle present. Ventral surface more or less flattened, with a small apical depression. Anterior tibiae shorter than in *Ae. inuus*, with a dense brush of black bristle-like hairs on under and inner surface, extending farther on to the inner surface at apex. *Dimensions* ♂ 10 x 4.5 mm.

Hab—Western Australia Cunderdin (T G Sloane)

Described from two specimens, both males. The species closely resembles *Ae minus* but is distinguished by the tibial clothing, the elytral sculpture is also somewhat more rugose, though the tubercles are not larger. From *Ae crawshawii* it differs in its larger size and more irregular elytral sculpture, and from *Ae. mendosus* in the more obtuse tubercles.

ANDRIODES CRAWSHAWI, n.sp

♂ Small, elongate, narrow. Black, moderately densely clothed with minute, black, subsquamose pubescence, variegated on elytra with grey, sides of elytra with more conspicuous white patches.

Head and rostrum as in *Ae minus* Pasc, except that the dorsal ridges are rather flatter and less defined. Prothorax evenly rounded on sides, median line sulcate, deepest where it crosses anterior constriction, sublateral foveae present, situated on anterior constriction, disc closely set with small, umbilicated setigerous granules. Elytra elongate, evenly rounded, and but little widened on the sides; apex little produced, rounded not mucronate, base emarginate, the ends of the third and fifth interstices advanced; dorsum with regular rows of small closely set punctures, interstices obscurely granulate, the third interstice feebly raised, incurved at base, with somewhat obscure setigerous granules, larger posteriorly, the last 2-3 forming small tubercles, the last the largest, conical, situated on edge of declivity, fifth interstice with humeral crest advanced, but less so than in most species, the outer edge with a row of granules, continued on to interstice and followed by 5-6 small tubercles, the posterior ones subconical and extending on to declivity, seventh interstice with obscure granules. Ventral surface slightly concave at base, almost flat elsewhere, with small setigerous punctures, a small foveiform depression present at apex. Anterior tibiae with a dense black hirsute brush on under surface extending round to inner side at apex.

♀ Similar to male, slightly larger, more produced at apex.¹ Elytra with tubercles more obtuse. Anterior tibiae less hirsute. Venter rather feebly convex. *Dimensions* ♂ 8 x 3 mm, ♀ 9 x 4 mm.

Hab—Western Australia Jandakot (W Crawshaw)

The outstanding character of this species would appear to be the small size, there are however other characters which prevent it being regarded as a variety of any other of the described species. The smaller elytral tubercles and the strongly hirsute tibiae distinguish it from *Ae minus* Pasc, and the more regular elytral sculpture from *Ae tibialis*. The extension of the tubercles of the fifth interstice on to the declivity is not absolutely constant.

I am indebted to Mr W Crawshaw of Jandakot for a fine series of this, the smallest species of the genus.

ANDRIODES MENDOSUS Pasc

Pascoe, Ann Nat Hist., 1872, p 86.

♀. Elongate, narrow. Black; rather sparsely clothed with minute almost squamose subpubescence, ochreous or metallic coppery in colour, denser on the head, sides with whitish patches.

Head as in *A. minus*, but scape much shorter and stouter. Prothorax as in *A. minus* but median impression somewhat deeper in basal portion. Elytra elongate, gradually widened, humeral crests larger than in *A. minus*; disc with distinct rows of granules on and between the interstices; second interstice with more

evident granules; third slightly incurved and projecting forwards at base, with a row of 8 tubercles, more or less conjoined at base, gradually increasing in size posteriorly, the last 3 conical, fifth projecting forwards in a large humeral crest, bordered on outer side by a row of small granules, and with a row of 4-5 conical tubercles, larger posteriorly. Sides with interstices broader, and punctures smaller than in *A. minus*, with fine granules scattered on interstices. Under surface gently convex at base. Legs shorter, and almost straight. *Dimensions* ♀. 10 x 4 mm.

Hab—Western Australia Albany

The above description is taken from the type—a female—in the British Museum. A second specimen in the collection is a male, and agrees fairly closely with the female except that the scape is not so short. The anterior tibiae also are stouter than in *A. minus* with stronger hair clothing the inner surface.

ALEXIRHEA

Pascoe, Journ Linn Soc, xii, 1873, p 19

Small, elongate elliptical in ♂, broader more ovate in ♀. Head convex, with a deep transverse sulcus at junction with rostrum, supraocular ridges present. Rostrum short, wide, the upper surface with internal ridges raised in a short backwardly projecting tubercle at base; lateral margins well-defined, not raised, clypeal plate exerted, submentum dentate, scrobes strongly curved, separated from eye by a short vertical sulcus. Antennae with scape moderately short, incrassate, and short funicular joints. Eyes ovate, finely faceted. Prothorax with lateral margins rounded or with posterior half sloping in an oblique line towards base, apical margin slightly produced above head, subtruncate, with definite ocular lobes, pronotum convex, granulate. Elytra elongate in ♂, broader more ovate in ♀, base emarginate, humeral angles produced or rounded, interstices granulate, with some small tubercles about edge of declivity. Venter flattened in ♂, with a median hirsute vitta, gently convex in ♀. Legs short, tarsal joints short.

While possessing no strongly marked salient features, this genus appears quite distinct, it is possibly most nearly allied to *Bubaris*, though in some respects it seems related to *Chrotaphus*. From *Bubaris* it may be distinguished by the tuberculate rostrum, the raised ends of the internal ridges forming a pair of definite tubercles, which is not the case in *Bubaris*.

Alexirhea was proposed by Pascoe for the reception of three species—*notata*, *aurata*, and *falsifica*, subsequently a fourth species—*singularis*—was added. The separation of the different species is a matter of some difficulty even after examination of the types. *A. falsifica* is abundantly distinct, but *A. singularis* was founded on a monstrosity, and does not appear to be separable from *A. aurata*. Of the position of *A. notata* I am more doubtful and, while retaining the name for the present, think that in all probability it will in time be sunk as a synonym of *A. aurata*. The latter species is the one commonly identified in collections and I would suggest designating it as the genotype. There is another species before me represented by an undescribed female, allied to *A. falsifica*, but with projecting humeral angles. The round shoulders seem restricted to the female sex, but as is shown by the above specimen, advanced shoulders are not necessarily characteristic of the male.

All the species belong to Western Australia, *A. aurata* occurring in the Swan

River district and *A. falsifica* at Geraldton, the precise locality of the type of *A. notata* is unknown

Table of Species

1	(4) Without subapical tubercle	
2	(3) Prothoracic lateral margins rounded	<i>A. aurita</i>
3	(2) Basal portion of margin straight	<i>A. notata</i>
4	(1) With a prominent conjoined subapical elytral tubercle	
5	Humeral angles rounded in female	<i>A. falsifica</i> .

ALEXIRHEA AURITA Pasc

Pascoe, Journ Linn Soc, xii, 1873, p 20 — *A. singularis* Pasc, Ann Nat Hist, (4), xvi, 1875, p 55

♂ Small Densely clothed with golden brown subpubescence, variegate with grey on elytra, the grey clothing most marked across declivity, ventral surface with a black median vitta

Head convex, separated from rostrum by a distinct transverse impression. Rostrum short, internal ridges erect and prominent at base, separated by a narrow impressed line. Scape of comparatively moderate length, strongly incrassate. Prothorax moderately strongly rounded on sides, basal angles obtuse, disc with a shallow median longitudinal impression, closely set with small round granules. Elytra elongate, very little widened posteriorly, apex rounded, not greatly produced, base rather deeply emarginate, the humeral angles produced forwards, interstices finely granulate, the second, third and base of fifth more raised, with two dentiform tubercles on the second and third (the inner the larger), forming a row across upper portion of declivity, also with two other smaller projections above declivity. Under surface flattened. *Dimensions* ♂ 5 lines (Pascoe)

Hab—Western Australia (Pascoe) Swan River. Gin-gin

The above description is taken from the type in the British Museum. I do not think that *A. singularis* can be separated from *A. aurita*. The type of the former is a female and deformed, the prothorax being cleft in the middle. The following description was drawn up from the type —

♀ Clothing dark, prothorax bivittate with lighter, elytra with a broad median stramineous band, with black maculae and a broad transverse fascia across the upper portion of declivity.

Head and rostrum as in other species, scape short, strongly incrassate. Prothorax deformed, the two sides not meeting above, closely granulate. Elytra rather broad, apex moderately strongly produced, base feebly emarginate, the humeral angles rounded, interstices granulate, the second, third and fifth slightly more raised, with somewhat larger granules above edge of declivity, two of them larger, almost tubercles, situated above the position of the lower row in *A. aurita*, also with a moderately strongly pointed tubercle on the second interstice, half-way down declivity. Ventral surface gently convex, with a short grey median vitta on fourth segment. *Dimensions* ♀ 4½ lines (Pascoe)

With the types of Pascoe's two species I was able to compare a short series of both sexes taken by Mr Carter at Gin-gin in Western Australia. The males varied in colour but generally speaking were darker than *A. aurita*, I can however detect no structural difference, the females appeared inseparable from *A. singularis*, the rounded shoulders being in this species evidently a sexual difference.

found in the female. At first sight the scape in *A. singularis* would appear to be shorter than in *A. aurita*, but after careful examination of the specimens now available I am satisfied that the apparent differences are due to variation in position.

ALEXIRHEA NOTATA Pasc

Pascoe, Journ Linn Soc, xii, 1873, p 20, Pl II, fig 4

♀ Size comparatively large for the genus. Densely clothed with brown silky subpubescence, trivittate with white on prothorax, variegate with silvery grey or white on elytra, the lighter clothing covering the greater part of the surface.

Head separated from rostrum by a transverse impression. Rostrum with two raised subparallel ridges projecting strongly upwards and backwards at base, median line linearly impressed, lateral margins not raised, separated from the dorsal ridges by a slightly depressed area, ridges cancellate-punctate. Scape comparatively long, rather strongly incrassate. Prothorax with sides straight from basal angle to beyond middle, thence narrowed to apex, the opposite sides almost parallel, median line but little impressed, disc closely set with small round granules. Elytra rather feebly rounded on sides, apex much produced, base with humeral angles rounded, not produced, disc with punctures small, regular, concealed, interstices little raised, the fifth slightly raised at shoulder, granules, if present, obscured by the clothing, two small dentiform tubercles on the second and third interstices respectively set in a transverse line near summit of declivity, with a smaller one on each side above them. Under surface convex. *Dimensions* ♀ 5½ lines (Pascoe).

Hab—Western Australia

The foregoing description was taken from the type in the British Museum. I have seen no other specimen which exactly corresponds with the type, particularly in the shape of the sides of the prothorax, and it is possible that the specimen may be aberrant in this respect.

A series (1♂, 3♀) from Mundaring and Jandakot in the Swan River district, for which I am indebted to Messrs Clark and Crawshaw, appear to me probably conspecific; the sides of the prothorax are straight from near the base to beyond the middle but the basal angle is somewhat more rounded than shown in Pascoe's figure, the clothing is abraded in all the specimens. The male has the humeral angles advanced and is close to *A. auritus*, but the prothorax is not evenly rounded as in that species, while there are minor differences in the size of the granules and punctures.

ALEXIRHEA FALSIFICA Pasc

Pascoe, Journ Linn Soc, xii, 1873, p 21

♀ Clothed with dingy subpubescence, prothorax feebly vittate near sides, humeral angles touched with grey.

Head and rostrum as in *A. aurita*, antennal scape comparatively long, strongly incrassate but less so than in *A. aurita*. Prothorax with granules somewhat more prominent, otherwise as in *A. aurita*. Elytra broader, rather strongly produced at apex, mucronate, base gently emarginate, humeral angles rounded, interstices granulate, the third and fifth more raised, with somewhat larger granules on each side near summit of declivity and also above declivity, these granules marked by denser clothing and in the position of the tubercles in *A. aurita*, also with a large long spiculiiform tubercle immediately above apex.

apparently rising from the second interstice and touching its fellow of the opposite side Under surface convex Dimensions ♀ 5 lines (Pascoe)

Hab—Western Australia Champion Bay

I have seen a number of specimens of this species but all females, the extraordinarily developed subapical tubercle may therefore be confined to the female.

SOSYTELUS

Pascoe, Ann Nat Hist., (4), x, 1872, p 90.

Small, elongate, widened posteriorly Head convex, forehead slightly depressed, supraciliary ridges present. Rostrum short and wide, the upper surface sloping downwards towards apex, straight above, depressed in midline with moderately elevated internal ridges Scrobes strongly curved, reaching to eyes Clypeal plate exerted, directed forwards Submentum strongly lobed Antennae short. Eyes ovate. Prothorax subangulate on sides, subplanate above, apical margin not produced above, ocular lobes present. Elytra rather strongly ampliate posteriorly, subplanate above, humeral angles produced Prosternum not excavate, venter flattened Tarsi short, the posterior somewhat longer

Genotype, *S. lobatus* Pascoe

In general facies this genus resembles both *Melanegus* and *Atychoria*, but is separated on account of the broader, shorter rostrum I cannot see that it has any affinity to *Oditesus*

But one species known of the genus—*S. lobatus* Pascoe, described in 1872 A second species—*rugicollis*—was however described by Lea (Proc Linn Soc N S Wales, xx, 1895, p 305) This species however is certainly not congeneric with *Sosytelus lobatus* Pasc, and in the present paper I have referred it to *Amorphophanus*, to the species of which it is much more closely related

SOSYTELUS LOBATUS Pascoe.

Pascoe, Ann Nat Hist, 1872, p 91, t 1, fig 1

♂ Small Black, clothed with very minute sooty squamulae, nigro-setose.

Head convex, forehead slightly concave, feebly rugulose, with moderately well marked supraciliary ridges Rostrum separated from head above by a transverse sulcus, short, thick, rather broad, upper surface sulcate in middle, internal ridges short, moderately prominent; the whole rather rugosely punctured Prothorax not greatly dilatate, subangulate on sides, apex subtruncate above with well marked ocular lobes, subapical constriction marked, dorsum subplanate, with well marked, though somewhat irregular, longitudinal median and sublateral sulci, intervening surface raised, ridge-like, the whole set with small, round umbilicate granules, most distinct on the elevated portions, sides granulate above, punctate below Elytra strongly widened from base to level of declivity, thence suddenly narrowed, base with humeral angles strongly advanced, directed slightly inwards, the ends of the third interstices also advanced. Dorsum subplanate, crossed by three, somewhat irregular, transverse ridges, the first across the middle of the elytra, the second midway between the first and the declivity, the third and most conspicuous across the edge of the declivity, third and fifth interstices raised, each with a series of elevations on the lines of the transverse ridges. Sides with regular rows of punctures, the interstices not granulate. Venter flattened, somewhat rugosely setigero-punctate

♀ More amphiately posteriorly, venter convex at base. *Dimensions* ♂ 10 x 4 mm; ♀ 11 x 5 mm

Hab—N S Wales Sydney, Blackheath

The elytral sculpture is difficult to describe adequately and somewhat variable, in some specimens the elevations on the third and fifth interstices are more marked and isolated, the cross connecting ridges being less evident. One specimen, in Mr. Lea's collection, without locality, has the elevations magnified into distinct tubercles, and the humeral crests distinctly separated from the rest of the fifth interstice

ATYCHORIA

Pascoe, Journ of Ent., 11, 1865, p 416

Size small, widened posteriorly, produced at apex. Head convex Rostrum moderately short, the upper surface obliquely truncate at apex, with a rather broad median furrow, the internal ridges strongly raised and thickened posteriorly, impinging on head, lateral margins straight, obscured from above by the internal ridges, clypeal plate strongly exerted Submentum lobate Scrobes gently curved, antennae short Eyes ovate, strongly acuminate below, finely faceted Prothorax rather narrow, rounded on sides, the apical margin slightly produced above, with strong ocular lobes, dorsum with median and sublateral sulci, separated by low ridges, surface granulate Elytra widened to level of declivity, thence suddenly narrowed and produced to apex, disc subplanate Legs comparatively short, tarsi short

Genotype, *Atychoria funesta* Pascoe

The genus is most closely allied to *Melanegis* from which however it differs in the more prominent rostral ridges, in the narrower prothorax and in the shorter antennae and legs From *Sosytelus*, to which it also appears to be related, *Atychoria* differs in its relatively longer and narrower rostrum, with more elevated ridges, the prothorax is also narrower

The genus was formed by Pascoe in 1865 (Journ Ent, 11, p 415) for a new and peculiar species from South Australia

Blackburn in 1896 (Report Horn Exped, 11, Zool, p 294) somewhat doubtfully proposed a second species—*rufus*—as a member of the genus Blackburn's species has however no connection with *funesta* and I have removed it to *Bubaris*

Misled by Blackburn's determination of the genus, I proposed in 1915 (Trans. Roy. Soc S Aust., xxxix, p 86) the name of *Melanegis halmaturina* for what subsequently proved to be *Atychoria funesta* Pasc The genus therefore remains monotypic

ATYCHORIA FUNESTA Pasc

Pascoe, Journ Ent., 11, 1865, p 416, t xvii, fig 22 —*Melanegis halmaturina* Ferguson, Trans Roy Soc S Aust, xxxix, 1915, p 86

Having had an opportunity of examining the type of Pascoe's species, I now regard the Kangaroo Island species as almost certainly the same The actual type of *funesta*, a female, is larger than *halmaturina* with somewhat different elytral prominences, but the differences are not greater than can be seen in a series of the closely related *Sosytelus lobatus*

In describing *M halmaturina* I did not suspect its identity with *Atychoria* as the only species known to me which had been ascribed to that genus was *Atychoria rufus* Blackb., which is not even generically closely related

Hab.—South Australia (Pascoe): Kangaroo Island.

MELANEGIS

Pascoe, Trans Ent Soc Lond, 1870, p 45

Small, elongate Head convex, forehead somewhat depressed, with well-marked supraciliary ridges Rostrum short, though somewhat longer than in *Sosytelus* and relatively more slender, the upper surface deeply sulcate, with long internal ridges, lateral margins distinct, clypeus strongly exerted, looking forwards, submentum lobed Scrobes curved, shallow posteriorly Antennae moderately long, the scape comparatively slender, funicle with the two basal joints moderately elongate, the second the longer Eyes ovate, finely faceted Prothorax rounded on sides, hardly produced above, ocular lobes present, dorsum subplanate, with longitudinal median and sublateral impressions Elytra widened posteriorly, humeral angles strongly advanced, disc planate, tuberculate Prosternum not excavate Ventral surface flattened Posterior tarsi moderately long

Genotype, *Melanegis stygius* Pasc

Melanegis presents in its general facies a strong resemblance to both *Sosytelus* and *Atychoria*. From the former, it may be differentiated by the longer rostrum, while the latter is distinguished by the peculiar form of the internal rostral ridges. The structure of prothorax and elytra is on the same plan in the three genera though there are minor differences. The legs however are somewhat longer and in this respect and in the more elongate rostrum the genus shows an affinity to *Tetralophus*.

I cannot satisfy myself that the clothing of the ventral surface of the tarsi, stressed by Pascoe, is of generic importance since other genera possess closely similar clothing.

The genus was erected by Pascoe in 1870 for a single species—*stygius*. In 1915 (Trans Roy Soc S Aust, xxxix, 1915, p 86) I described a second species—*halmaturinus*. This now turns out to be an *Atychoria* and a synonym of *A. funesta* Pasc, previously unknown in Australian collections.

MELANEGIS STYGIUS Pasc

Pascoe, Trans Ent Soc Lond, 1870, p 452, t vii, fig 6, Lea Mém. Soc. entom. Belgique, xviii, 1910, p 88

Small, black, covered with brown subpubescence

Head convex, slightly depressed in front, with a slight ridge in front of the eyes on each side. Rostrum as long as, but narrower than, the head, not separated above by a distinct impression, upper surface about one half the total width of the rostrum, deeply sulcate in median line, with prominent slightly divergent ridges, separated from the lateral borders by a narrow sublateral sulcus, lateral margins rounded in front, not conspicuously raised, and lying below the level of the internal ridges at the base. Scrobes curved, extending towards but not reaching lower pole of eyes. Antennae slender, the scape comparatively long, the first two joints of funicle elongate, the second longer than the first, the remaining joints short. Prothorax subangularly rounded on sides, widest about middle, apical margin somewhat produced above, with well marked ocular lobes, disc strongly convex, with a deep rather broad median impression, becoming less marked posteriorly, also with a deep somewhat oblique sulcus on each side in anterior half, the surface between the sulci raised into ridges, the rest of the surface set with small round granules extending on to upper part of the sides. Elytra elongate, gradually widened to level of declivity, then rather abruptly rounded to apex, base emarginate, with strongly projecting humeral angles, and

slight forward projections of the third interstices, disc flattened, with small punctures in fairly regular series, third interstice somewhat raised, in a row of obscure granules culminating in a small tubercle behind middle, fifth interstice with 3 very large outwardly projecting tubercles, becoming larger posteriorly, the last situated at level of declivity, seventh interstice lateral, without definite tubercles. Sides with rather larger punctures, the interstices with small obscure granules. Ventral surface flat, the intermediate segments rather long, with somewhat scattered fine setae and sparse black pubescence in the mid-line. Posterior tarsi comparatively short. *Dimensions* ♂ 10 x 4 mm.

Hab—Western Australia. King George Sound (Albany).

The above description was drawn up from a specimen in Mr A. M. Lea's collection, I have however examined the type, and am certain of the identification, since I possess a second specimen, not in too good preservation, which was compared with the type.

TETRALOPHUS

Waterhouse, Trans. Ent. Soc., 11, 1853, p. 173; Lacordaire, Gen. Coleop., vi, 1863, p. 317.

Size small to moderate, elongate, oblongate, almost parallel-sided. Head partially concealed by prothorax, supraciliary ridges present. Rostrum comparatively long and narrow, upper surface sulcate in median line with well marked internal ridges. Clypeal plate strongly exerted, looking forward. Scrobes strongly curved. Antennae moderately long with rather long scape. Submentum lobed. Eyes ovate. Prothorax produced at each side into a strong angulate tubercle, apical margin strongly produced above, ocular lobes well developed, dorsum convex with strongly raised admedian ridges. Elytra oblongate, humeral angles strongly produced, cristiform, dorsum with two rows of tubercles, on the third and fifth interstices respectively. Posterior tarsi moderately elongate.

Genotype, *T. sculpturatus* Waterhouse.

The shape of the prothorax and the arrangement of the elytral tubercles render this genus one of the most distinct of the group. Its immediate affinities are not obvious, but the elongate rostrum suggests a relation with *Dialeptopus*, a genus in other respects strikingly different.

Tetralophus was founded by G. R. Waterhouse in 1853 for the reception of a new species—*sculpturatus*. In 1870 Pascoe described 3 additional species—*excursus*, *elevatus* and *incanus*. The first two of these however do not appear to be specifically distinct, while it is doubtful if *incanus* should be considered as more than a variety of *T. sculpturatus*. The number and development of the elytral tubercles is so subject to variation that species founded on differences in regard to the tubercles are not likely to prove distinct.

The genus is restricted to the southern portion of Victoria and South Australia, possibly extending into Western Australia. *T. sculpturatus* is the eastern species and *T. excursus* the western, *T. incanus* being also found in Victoria. I am not yet certain of the exact range of each species or whether they overlap.

TETRALOPHUS SCULPTURATUS Waterhouse

Waterhouse, Trans. Ent. Soc., 11, 1853, p. 174; Lacordaire, Gen. Curc., Atlas, vii, t. 67, fig. 5a.

Variable in size and development of elytral tubercles, prothorax not granulate. Black; with sparse subsquamose clothing.

Head with a feeble median ridge in centre, lightly concave on each side, supraciliary ridges present, not prominent. Rostrum with internal ridges long, prominent, convergent at base, separated from the lateral margins by a space communicating with the forehead, lateral ridges low. Prothorax with lateral tubercle large, obliquely truncate, the anterior angle rounded, the posterior pointed, apex strongly produced above, subapical constriction well marked, median area strongly depressed, bounded by a strongly elevated ridge on each side, subdivided into three portions, a short ridge anterior to subapical constriction extending above head, a longer more elevated median or main portion and a small tubercle at posterior end of median portion, derm not granulate. Elytra oblongate, humeral angles with a strongly developed, outwardly and forwardly projecting tubercle, truncate at apex, third interstice with a row of tubercles, small, rounded near base, gradually increasing in size and becoming more conical posteriorly, the last situated some distance before declivity, the number of tubercles in the row inconstant, the last 2-3 sometimes united; fifth interstice bearing the large humeral tubercle, and an equally large but more conical tubercle at level of declivity, also with 2-3 smaller conical tubercles between. Ventral surface more or less flattened, with a small depressed area at extreme apex, filled with pubescence, the apical segment somewhat bulbous in front of depression.

♀ Gently convex at base of abdomen, without definite apical depression.

Dimensions ♂ 10-13 x 3 5-5 mm, ♀ 11-13 x 4 5-5 mm

Hab—Victoria, South Australia. Most specimens without exact locality, several labelled Lucindale, South Australia.

A very variable species in size and in the number and development of the elytral tubercles. The practically non-granulate prothorax will distinguish the species from *T. excursus* Pasc. though in several specimens there are a few granules at the base of the prothorax.

TETRALOPHIUS INCANUS Pasc

Pascoe, Trans Entom Soc London, 1870, p 453

It is doubtful if this species should be regarded as more than a variety of *T. sculpturatus* Waterhouse. It is distinguished by the fewer tubercles on the third interstices, commonly one or two, but indications of smaller obsolescent tubercles nearer the base are sometimes present and such specimens tend to bridge the gap between *T. incanus* and typical specimens of *T. sculpturatus*. Sufficient material is not available to settle the status of the species which may prove a geographical race of *T. sculpturatus*. Most of the specimens, about 6, that I have seen were labelled either Victoria or South Australia, but one specimen is labelled as from Ararat in Victoria.

TETRALOPHIUS EXCURSUS Pasc

Pascoe, Trans Entom Soc. Lond, 1870, p 453.—*T. elevatus* Pasc, l.c., p 453.

Head and rostrum very similar to *T. sculpturatus*, submentum broadly lobed, not much produced. Prothorax broader, the ridges shorter, not extending farther back than opposite the posterior border of the lateral tubercle, without a separate nodule at the posterior end, surface granulate; sides granulate. Elytra relatively shorter and broader, with fewer and rather larger tubercles; the third interstice with a single tubercle beyond middle, sloping anteriorly with or without an

obscure row of granules extending to base of elytron, fifth interstace with large humeral and subapical tubercles, and one or two smaller conical tubercles between
Dimensions ♂ 11-15 x 5-6 mm; ♀ 11 x 5 mm

Hab—S Australia. Mt Lofty, Mylor, Prospect Hill, Kangaroo I

The distinction drawn by Pascoe between *T. excursus* and *T. elevatus* does not appear to me of specific importance. The distinction was that in *T. excursus* there is a row of granules between the median tubercle on the third interstice and the base, while in *T. elevatus* the granules are absent, the tubercle merely sloping towards the base. The series before me shows that the granules vary in development so that there is a complete transition between *T. excursus* and *T. elevatus*. The granularity of the prothorax also varies to a slight extent, as well as the width of the prothorax.

The species differs from *T. sculpturatus* in the granular prothorax and in the shape of the prothoracic crests.

DIALEPTOPUS

Pascoe, Trans Ent Soc Lond, 1870, p 450

Moderately large species, elongate, narrow in ♂, more ovate in ♀. Head concealed to large extent by prothorax, strongly convex. Rostrum moderately long, longitudinally impressed on upper surface, with long, little prominent internal ridges, lateral margins low, clypeal plate rather strongly exerted, submentum briefly lobate. Scrobes feebly curved. Antennae moderately long. Eyes ovate, finely faceted. Prothorax with median area strongly raised above rest of surface, depressed in middle and bounded by strongly raised ridges, more or less widely separated in middle, slightly incurved towards base and strongly convergent apically projecting well over the head, lateral margins rounded, apical margin strongly produced above, with strong ocular lobes. Elytra elongate, almost parallel-sided in ♂, rather strongly ovate in ♀ and produced at apex, base strongly emarginate, the humeral angles projecting forwards, embracing the base of the prothorax, dorsum puncto-striate, the third and fifth interstices tuberculate, the third out-turned at base to join the fifth and form the humeral crest, sides puncto-striate. Prosternum gently concave with a small tubercle on each side, in front of anterior coxae. Legs long and slender; tarsi elongate, the posterior tarsi very long.

Genotype, *Amycterus collaris* Bohemann = *D. sepidioides* Pascoe

The curiously sculptured prothorax and the prominent humeral crests formed by the junction of the third and fifth interstices render this genus readily recognizable.

It is probably most closely allied to *Tetralophus*, the rostrum being similar in both genera, though the structure of prothorax and elytra differ greatly.

The genus was formed by Pascoe in 1870 (Trans Ent Soc. Lond., p 450) for *Amycterus collaris* Bohem (1843), and four new species—*ferreus*, *macilentus*, *monachus* and *sepidioides*, the latter being founded on the same species as *collaris*. Subsequently Pascoe described (Journ Linn Soc xi, 1872) three additional species—*granulatus*, *plantaris* and *serricollis*, of which the first two are founded on the sexes of the same species.

Blackburn (Proc Linn Soc N S Wales, 1890) proposed four new species—*lugubris*, *validus*, *obsoletus*, and *indensis*, and in 1892 (*op cit*) a further one—*approximatus*. Only two of these species appear to be valid, as two, *validus* and *lugubris*, are founded on the one species, while *approximatus* falls to *collaris* Bohem., and *obsoletus* does not appear to be distinct from *ferreus* Pascoe.

Lea (Proc Linn Soc N S Wales, 1896) described three species, *echinatus*, *longipes* and *sordidus*. Of these *longipes* seems to be the same as *macilentus* Pascoe, and *sordidus* only a form of the highly variable *D. collaris* Bohem. Subsequently Lea (Trans Roy Soc S Aust, 1910) added another species, *pyriferus*, which is identical with *D. ferreus* Pascoe.

It will be seen from the above review how heavy the synonymy is in the genus. This is in part due to several of Pascoe's species not having been recognised in Australian collections, but in the main to the great variability of the species. Excluding the synonyms, nine names are retained as applying to valid species, it is possible that this number should be still further reduced, the characters upon which they are separated being rather weak.

Distribution—The genus appears to be restricted to Western Australia and South Australia, with possibly the neighbouring portion of Victoria. *D. monachus* was described as from New South Wales, but this is certainly incorrect as regards the present boundary of that State.

Table of Species

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|---------|--|-----------------------------|
| 1 (2) | Elytra with three rows of tubercles on each side | <i>D. echinatus</i> Lea. |
| 2 (1) | Elytra with two rows of tubercles on each side | |
| 3 (4) | Width across humeral processes equal to width of prothorax | <i>D. validus</i> Blackb. |
| 4 (3) | Width across humeral processes less than width of prothorax | |
| 5 (8) | Basal segment of abdomen with a pair of conspicuous, parallel, longitudinal ridges | |
| 6 (7) | Apex of elytra emarginate, bluntly mucronate on each side | <i>D. collaris</i> Bohem. |
| 7 (6) | Apex of elytra deeply emarginate, with a long sharp process on each side | <i>D. macilentus</i> Pascoe |
| 8 (5) | Basal abdominal ridges low or absent | |
| 9 (10) | Prothorax strongly granulate, ♂ with first posterior tarsal joint dilate | <i>D. plantaris</i> Pascoe |
| 10 (9) | Prothorax not granulate between the ridges tarsi normal | |
| 11 (14) | Median area of prothorax normally widened | |
| 12 (13) | Punctures obsolescent, tubercles sharp, elevated | <i>D. monachus</i> Pascoe |
| 13 (12) | Punctures evident, tubercles less elevated, more outwardly directed | <i>D. ferreus</i> Pascoe |
| 14 (11) | Prothoracic median area less widened than usual the apices of the ridges rather widely separated | <i>D. lindensis</i> Pascoe |

DIALEPTOPUS COLLARIS Bohem

Amycterus collaris Bohemann, *Schönh. Gen. Spec. Cure*, vii, (1), 1843, p. 57—*Euomus collaris*, *Schönherr, Mantiss. Sec. Cure*, 1847, p. 54, Lacordaire, *Gen. Col.*, vi, 1863, p. 316, note 2—*Dialeptopus sepidioides* Pascoe, *Trans. Ent. Soc. Lond.*, 1870, p. 450, t. 7, fig. 4a, Blackburn, *Proc. Linn. Soc. N S Wales*, (Ser. 2), v, 1890, p. 581, Lea, *Trans. Roy. Soc. S. Aust.*, xxxiv, 1910, p. 25, Lea, *Mém. Soc. entom. Belgique*, xviii, 1910, p. 88—*D. approximatus*, Blackb., *Proc. Linn. Soc. N S Wales*, vii, 1892, p. 124—*D. sordidus*, Lea, *Proc. Linn. Soc. N S Wales*, xxi, 1896, p. 297.

This species is extremely variable in size and in the elytral tuberculation. After the examination of a long series of specimens from various parts of Western Australia I am led to the conclusion that all the forms belong to but one species,

and that the species described by Pascoe, Blackburn and Lea cannot be maintained as distinct.

Fresh specimens are more or less densely clothed and much of the surface of the elytra is covered with an enamel which readily becomes abraded or discoloured. The sexes differ greatly in form, the male being elongate and narrow, while the female is strongly ovate. The elytral tubercles are also stronger in the male than in the female.

These tubercles in the male vary from 5 to 9 in number on the third interstice, and from 3 to 7 on the fifth interstice. The usual number appears to be 6-7 on the third interstice and 4-5 on the fifth. Usually there are some small granules extending from the base of the humeral crests to the definite tubercles on the third interstice, the length of the row of granules varies and it is often difficult to decide where the tubercles actually start, in some, particularly in the females, this portion of the interstice may be subcostate. The tubercles often differ on the two elytra of the same specimen. The foveiform punctures vary somewhat in size and distinctness, depending to some extent on the degree of abrasion of the clothing. On the basal ventral surface are two prominent short longitudinal ridges between the hind coxae and the mid-line. These are present also in *D. macilentus*, but obsolete though traceable in *D. monachus* and *D. ferreus*.

The length varies from 14 to 17 mm in the male, and from 13 to 17 mm in the female.

In describing *D. approximatus* Blackburn stated that the second joint of the posterior tarsi was but little shorter than the first, Mr Carter at my request examined the type and informs me that the second joint is about one-third shorter, which is the case normally in *D. collaris*.

DIALEPTOPUS SERRICOLLIS Pas.

Pascoe, Journ. Linn. Soc., xi 1872, p. 449

♀ Of moderate size, strongly ovate. Black, elytral tubercles reddish, head and rostrum clothed with yellow subpubescence.

Rostrum parallel-sided, with parallel internal ridges, the median line hardly depressed. Prothorax with median area narrowly pyriform in shape, moderately deep, bounded by the submedian ridges, the latter fading away posteriorly not abruptly terminated and set with strongly setigerous granules rather confusedly arranged; lateral ridges strongly convex, granulate. Elytra obese, strongly ovoid, humeral crests rather close and small, but well advanced, each with several conical granules on the outer edge, third interstice with 6-7 tubercles, closely set, almost spiniform, the last half way down declivity, also one or two granules at base of interstice, fifth interstice with a row of tubercles continued from spicules of crest, consisting of 6 strongly conical spiniform tubercles, outwardly projecting, the apical tubercle almost reaching the same posterior level as the last tubercle of third interstice, punctures on dorsum well marked and deep. Sides with rather large and deep punctures, the interstices not carinate. Beneath convex, apical impression obsolescent. *Dimensions* ♀ 13 x 5 mm.

Hab—Western Australia.

The above description was taken from the type in the British Museum, I have not seen another specimen of the species.

As the male is unknown I have not included the species in the tabulation of the genus, but in all probability it comes closest to *D. collaris*, from which it is

distinguished by the marked granularity of the prothoracic ridges and humeral crests

DIALEPTOPUS MACILENTUS Pasc

Pascoe, Trans Ent Soc Lond, 1870, p 451 —*D longipes* Lea, Proc Linn Soc N S Wales, xxi, 1896, p 296, Lea, Trans. Roy Soc S Aust, xxxiv, 1910, p 25

The type (♂) of *D macilentus* Pasc was examined at the British Museum, it is labelled as being from South Australia, though other specimens in the same collection are labelled Albany. The series from Albany and Mt Barker recorded by Lea (Trans Roy Soc S Aust, xxxiv, 1910, p 25) certainly belong to this species. As these specimens were considered by Lea to be conspecific with *D longipes* Lea, this name falls into synonymy.

DIALEPTOPUS MONACHUS Pasc

Pascoe, Trans Ent Soc Lond, 1870, p 451

♀ Size moderately large, ovate. Black, densely covered with yellowish meal, with evidence of white enamelling on the upper surfaces of the tubercles.

Head convex, separated from rostrum by a semilunar impression. Rostrum moderately long, median area deeply depressed, internal ridges prominent, convergent posteriorly. Scape of moderate length and stoutness. Prothorax of usual form, the median crests projecting over the head, enclosing a wide shallow pyriform area, the ridges approximated anteriorly and most widely separated posteriorly, where they end rather abruptly in front of base, lateral ridges rather strongly convex, subgranulate. Elytra moderately amphiate, apex not greatly produced, humeral crests normally advanced as in genus, derm and punctures obscured by meal, first row of tubercles 7-6 in number, basally degenerating into a continuous ridge outwardly directed and running on to humeral crest, the other tubercles strongly developed subtriangular, erect, with little lateral inclination, second row with 4-5 sharply cut, triangular tubercles, strongly outwardly directed, the base of the interstices forming the outer ridge of the humeral crest. Sides with only the interstices showing through the meal. Ventral surface convex, sparsely setigerous, apical segment with a circular pit at apex. *Dimensions* ♀ 14 x 6 mm.

Hab —South Australia.

The above description was taken from the type, a female, in the British Museum. Another female in the same institution has the derm more abraded and open subobsolete punctures are visible, also each of the tubercles of the inner row shows evidence of a single shallow depression.

A fairly extensive series in the collection of the South Australian Museum was commented upon by me in a former paper (Trans Roy Soc. S. Aust, xxxix, 1915, p 64, No 231) without however a name being attached to the specimens. Examination of Pascoe's types showed that this series was referable to *D monachus* Pasc.

The male differs in being smaller and narrower, almost with subparallel sides, and the elytral tubercles are larger and more acute; the ventral surface is flattened and the basal segment is obsoletely ridged, the parallel ridges described in *D collaris* being present but low and only visible from certain directions.

DIALEPTOPUS FERREUS Pasco.

Pascoe, Trans Ent. Soc. Lond, 1870, p 451.—*D. obsoletus* Blackb, Proc. Linn Soc N S Wales, 1890, p. 579 —*D. pyriferus* Lea, Trans. Roy Soc. S. Aust, xxxiv, 1910, p. 25

I have examined the type (♂) of Pascoe's species in the British Museum and cannot separate it from *D. pyriferus* Lea. The type of *D. obsoletus* Blackb, was also examined and I consider it to belong to the same species. It is a female with the tubercles less strongly developed, probably an individual variation.

D. ferreus is very closely allied to *D. monachus* and I doubt if it should be maintained as distinct. The elytral tubercles are as a rule more obtuse and more outwardly directed, while the punctures are larger, more foveiform and tend to impinge on the tubercles to a greater extent. It must be admitted that while intermediate forms occur, under *D. monachus* have been included a number of variations which further series may show to be of specific or subspecific rank. I think it well therefore for the present to maintain *D. ferreus* as distinct from *D. monachus*.

DIALEPTOPUS LINDENSIS Blackb

Blackburn, Proc Linn Soc N S Wales, 1890, p 580.

An elongate narrow species with few but strong elytral tubercles and with rather characteristic prothoracic crests, comparatively widely separated at apex and less divergent than usual in the middle.

DIALEPTOPUS PLANTARIS Pasco

Pascoe, Journ Linn Soc xi, 1872, p 449, t 12, fig 11 — *D. granulatus* Pascoe, loc cit, p 449; Lea, Mém Soc entom Belgique, xviii, 1910, p 88

♂. Elongate-ovate Black, covered with minute greyish clothing, with larger coppery squames in depressions.

Head completely concealed by the prothorax. Rostrum moderately long, the upper surface plane with the ridges obsolete. Prothorax with median area hardly depressed except for median line, the surface and ridges (which form the edges of the median area and are hardly different from it) closely set with moderately large round setigerous granules, the ridges parallel in anterior portion, then directed outwards to form a median angle, from which they are more gradually inclined to base, sublateral areas bare of clothing and without granules, lateral ridges evenly curved outwards in middle, granulate, sides granulate. Elytra elongate, ovate, humeral angles produced forwards, not outwards, disc with moderately well defined rows of punctures, with granules between, third interstice with granules at base, extending out to humeral angle, also with 4 strong conical tubercles, the last one situated on the edge of the declivity, fifth interstice with a row of 5 tubercles, larger posteriorly, extending from base of humeral crest but ending anteriorly to apical tubercle of third interstice, humeral crests not excavate between the ends of the third and fifth interstices, and set all over with round granules. Ventral surface flattened, with a few golden setae in middle, no ridges at base. Tarsi with basal joint much enlarged and thickened, on the middle and posterior legs, the posterior pair especially dilated.

♀. Resembles ♂, but larger and more obese, with the tarsal joints elongate and slender. Dimensions: ♂. 12 x 5 mm, ♀ 15 x 6 mm.

Hab—Western Australia: Geraldton.

Described from types of *D plantaris* and *D granulatus* in the British Museum

D plantaris differs from every other known species of the genus in the shape of the prothoracic ridges, in the granularity of the prothorax and in the tarsal joints of the male

DIALEPTOPUS VALIDUS Blackb

Blackburn, Proc Linn Soc NS Wales, 1890, p. 577 — *D lugubris* Blackb, loc cit, p. 578, Ferguson, Trans Roy Soc S Aust, xxxix, 1915, p. 63

I have examined the types of Blackburn's species, now in the British Museum. Each species is represented by a single specimen, evidently the ♂ holotype as determined by Blackburn. A comparison of the specimens showed that they certainly belong to but one species, the type of *D validus* being a ♀, and that of *D lugubris* a ♂. It is evident from Blackburn's comments that he was by no means certain of the sexes of his specimens.

In my previous notes I used both names as applying to distinct species. I am now of opinion however that all the specimens then examined as well as others in various collections belong to a single, somewhat variable species.

It might be added that in the type of *D validus* the scape is lying back, thus appearing shorter than is really the case.

DIALEPTOPUS ECHINATUS Lea.

Lea, Proc Linn Soc NS Wales, xxi. 1896, p. 295, Trans Royal Soc. S Aust, xxxiv, 1910, p. 24

This species is readily distinguished from all others by possessing three rows of tubercles on each elytron, large and acute in the male, shorter and obtuse in the female. Fresh specimens show beautiful black and white longitudinal vittae, but specimens are difficult to keep in this condition as the white enamel becomes abraded or darkened by grease. Specimens vary somewhat in shape, some being much narrower than usual, but this seems to be an individual variation.

CUCULLOTHORAX

Ferguson, Trans Roy Soc S Aust, xxxix, 1915, p. 88.

The clypeal plate is definitely though not strongly exerted, and the submentum is obtusely lobed in the mid line, there is no lateral impression on the rostrum below the scrobe and above the jaw. The anterior constriction, which surrounds the prothorax in most Amycterid genera, is wanting, and ocular lobes are practically absent though stated to be present in the original description. The two basal abdominal segments that are visible appear to be completely soldered together in the middle though the suture is distinct at the sides.

The above details are given to complete the original description, they are taken however not from the type but from the Warren River specimen. In the second line of the generic description the upper-surface should be read in place of under-surface.

CUCULLOTHORAX HORRIDUS Ferg

Ferguson, loc cit, p. 89.

Hab—Western Australia Mt Barker. Warren River

ODITESUS

Pascoe, Ann Nat Hist, (4), x, 1872, p. 88.

Size small Head strongly concave in front, with well-marked supraciliary ridges Rostrum comparatively short, the upper surface flat or gently concave in anterior portion, the internal ridges raised at base into a strongly projecting crest; external margins low, clypeal plate strongly exerted, submentum dentate, mandibles prominent, overlapping, strongly toothed Scrobes curved, extending down towards lower margin of eye Eyes ovate, finely faceted Prothorax flattened above, hexagonal in outline, with a dentiform tubercle at middle of lateral margins, apex slightly produced, subtruncate above, ocular lobes well marked, surface granulate Elytra oval, convex, humeral angles with upstanding crests, with two rows of tubercles and infra-humeral spine Legs rather long and thin, tarsi comparatively slender, the posterior with basal joints elongate

Genotype, *O. indutus* Pasc

Oditesus forms one of a small group of genera characterised by the possession of prominent rostral crests or tubercles In general habit it perhaps most closely resembles *Polycreta* and *Ennothus*, but is distinguished from these by the possession of ocular lobes *Acherres* is distinguished by the peculiar shape of the prothorax, while the new genus described below is also differentiated on this structure

The genus was described by Pascoe in 1872 for 6 species—*indutus*, *lycosarius*, *incoenus*, *perditus*, *sulcirostris* and *buceros* I have examined the types of these and can only conclude that the first 4 names belong to but one variable species The other two are more distinct, though it is still questionable whether they should be regarded as more than varietal forms

Lea in 1903 described one species—*tibialis*—which, on account of the difference in the structure of the prothorax, I have thought advisable to remove to a new genus

Oditesus appears to be restricted to the south-western portion of the continent, the range extending from King George Sound to Geraldton

Table of Species

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|---|-----|---|-----------------------------|
| 1 | (4) | Size small, interstices tuberculate | |
| 2 | (3) | Rostral crests large, more or less completely conjoined | <i>O. indutus</i> Pasc |
| 3 | (2) | Rostral crests small, separate | <i>O. sulcirostris</i> Pasc |
| 4 | (1) | Size larger, interstices at least partially costate | <i>O. buceros</i> Pasc |

ODITESUS INDUTUS Pasc

Pascoe, Ann Nat. Hist., 1872, p. 88, t. 1, fig. 6 — *O. incoenus* Pasc, loc. cit., p. 89 — *O. lycosarius* Pasc, loc. cit., p. 89 — *O. perditus* Pasc, loc. cit., p. 89

Small, ovate Black, moderately densely clothed with minute subsquamosity, varying in colour from grey to brown (obscured by dirt in type of *O. indutus*), sometimes appearing darker and with metallic copper reflections

Head broad, gently transversely concave, with somewhat raised supraocular borders Rostrum comparatively narrow, hardly excavate in front, basal crests large, erect, conical, conjoined at base, otherwise separated by a deep fissure, the apices divergent, this fissure extending anteriorly as a slight longitudinal impression Prothorax flat disc-like above, with a shallow median sulcus, sub-apical impression broad though somewhat ill-defined; anterior margin slightly produced, with 4 small dentiform projections, lateral margins with a short spine in front of middle and smaller ones anterior and posterior to it; disc with small granules, with one or two rather larger granules on either side of median line,

sides granulate Elytra granulate between the lines of tubercles, with two rows of spiniform tubercles, first row with a forward projecting tubercle at base of interstice, and with 4 spiniform tubercles, the last situated half way down declivity, the penultimate the largest, second row with a strong obliquely set humeral crest, quadridentate, and 3 acute spiniform tubercles, the last almost on the same posterior level as the last of first row, intra-humeral tubercle present, large, acute Sides with interstices granulate Under surface with scattered punctures, larger on metasternum and basal segments, apical segment with a rather feeble apical impression *Dimensions* 7.5 x 3.5 mm

Hab—Western Australia King George Sound, Mt. Barker

The above description was taken from the type, which is apparently a male, in the British Museum

I was able to compare critically the types of Pascoe's four species as well as the fine series in the British Museum, and although slight variations exist in the actual shape and in the degree of separation of the rostral crests, I cannot regard them as belonging to more than one species *O. lycosarius* and *O. perditus* have the crests larger than in *O. indutus* and *O. perditus*, but examination of the series shows that the shape of the crest is too variable to be regarded as of specific value

Though I have maintained *O. sulcirostris* and *O. buceros* as distinct, I think it is possible that they too should be regarded as varieties of the same species

ODITESUS SULCIROSTRIS Pasc

Pascoe, Ann. Mag. Nat. Hist., 1872, p. 90

♀ Head and rostrum much as in *O. indutus*, but rostral crests much smaller, and almost completely separated from each other Prothorax with spinules on lateral margins less distinct, with the exception of the median lateral spine. Elytra ovate, with third interstice raised into a low ridge uniting the tubercles which are much less developed and, except the last, not conical, fifth interstice with humeral crest followed by 3 small obtuse projections; infra-humeral spine present Under surface convex *Dimensions* ♀ 7 x 3.5 mm.

Hab—Western Australia Nicoll Bay, Champion Bay

The Champion Bay specimens have the rostral crests equally small, but less completely separated, while the elytral tubercles are well developed as in *O. indutus* I am inclined to regard the short crests as a specific difference, and the elytral sculpture as variable, possibly a sexual feature Among the series of *O. indutus* in the British Museum is a female with the elytral sculpture as in the type of *O. sulcirostris*

ODITESUS BUCEROS Pasc

Pascoe, Ann. Mag. Nat. Hist., 1872, p. 90

♀ Differs from *O. indutus* in being distinctly larger

Head much as in *O. indutus*; rostrum with crests large and broad, completely joined except at extreme apex Prothorax similar but rather more evenly granulate Elytra not granulate, with more evident punctures; third interstice raised, costiform from base practically to apex with only a slight projection corresponding in position to the third tubercle in *O. indutus*, fifth interstice with large humeral crest followed by three isolated obtuse tubercles; infra-humeral spine present Under surface convex, with scattered punctures. *Dimensions*: ♀ 10 x 4.5 mm.

Hab.—Western Australia King George Sound.

A second specimen differs from the type in having the crests more separated, and in having indications of the tubercles on the third interstice, the apical tubercle being distinct. Apart from the larger size this species differs from *O. indutus* in the more massive crests, while the elytral sculpture if constant should afford a means of separation.

PARODITESUS, n. gen

Size small. Head and rostrum as in *Oditesus*. Prothorax rounded on sides, apical margin slightly produced above, with well-marked ocular lobes; dorsum with median and sublateral longitudinal sulci; surface granulate. Elytra gradually widened posteriorly, subplanate above, with two rows of tubercles, humeral angles advanced, no infra-humeral spine. Legs similar, tarsi rather shorter.

Genotype, *Oditesus tibialis* Lea.

A new genus is necessary for the reception of *Oditesus tibialis* Lea. While closely agreeing with *Oditesus* in head and rostrum, the new genus differs both in the prothoracic and elytral sculpture. The prothorax suggests an affinity with *Bubaris* or *Aedriodes*, while the elytra is more reminiscent of *Melanegus* or *Sosytelus*.

PARODITESUS TIBIALIS Lea.

Oditesus tibialis Lea, Trans Roy Soc S Aust, xxvii, 1903, p 114.

The peculiar structure of the anterior tibiae, from which the species derives its name is present in both sexes, though more marked in the male.

A female from Swan River in Mr Lea's collection differs from other specimens before me in the less development of the elytral tubercles which are little more than mere undulations.

Hab.—Western Australia Mt Barker, King George Sound, Swan River.

POLYCRETA

Pascoe, Journ Linn Soc, xii, 1873, p 8.

Small, narrow, elliptical. Head convex, with markedly prominent eyes, the latter rotundate and finely faceted. Rostrum comparatively long and narrow, the dorsal surface about one-half the total width, internal ridges raised at base in a pair of short tubercles; clypeal plate exserted, mandibles unusually long obtusely pointed, and dentate, submentum dentate in middle. Scrobes widely open posteriorly. Antennae long. Prothorax tuberculate-dentate on sides, apical margin produced above, without ocular lobes, disc flattened, spinulose. Elytra oval, convex from side to side, with three rows of spiniform tubercles, and infra-humeral spine. Legs moderately long, posterior tarsi elongate.

Genotype, *P. metrica* Pascoe.

Though placed by Pascoe among the long-scaped *Amycterinae* and allied to *Hyborrhynchus*, the present genus appears to me to have more affinity with the *Euomides* and is indeed very closely related to *Ennothus*. The relationship of these two genera would appear to be with the small group of genera allied to *Oditesus*.

POLYCRETA METRICA Pascoe

Pascoe, Journ Linn. Soc, xii., 1873, p 8, t. 2, fig. 2.

♂. Elongate ovate, small, spinose. Black; densely covered with dark brown clothing, head, the middle line of prothorax, a band across summit of declivity

and sides of elytra with whitish clothing, median line of elytra tinged reddish brown

Head flattened in front, ocular margins very slightly raised, eyes prominent, rather large, subrotundate, finely faceted. Rostrum moderately elongate and comparatively narrow, the width of upper surface much narrower than total width of rostrum, upper surface slightly contracted in the middle, feebly impressed along median line, with a pair of raised triangular dentiform projections at base. Scape long, comparatively slender. Prothorax almost pentagonal in shape, sides angulate, spinose in middle, apical margin produced over head, ocular lobes absent, lateral margins with a moderately large, outwardly projecting spine in middle, with a small spinule in front and behind, apical angle truncate, each side with three erect spinules, disc flattened, without evident granules except one or two minute spinules about centre, on either side of the median line. Elytra suboval, the first, third and fifth interstices each with a row of small spiniform tubercles, on the first and third gradually increasing in size posteriorly, very small and subobsolete at base, each row ending in a small tubercle above the apical fascia and with a larger tubercle below fascia, these tubercles forming a transverse line across declivity, infra-humeral spine present, acutely produced. Under surface flattened, base slightly depressed. Legs with posterior tarsi moderately elongate. *Dimensions* 3-3½ lin (Pascoc)

Hab—Western Australia. Champion Bay (Geraldton)

The above description was drawn up from the type in the British Museum. The species is well figured by Pascoc and cannot well be mistaken for any other known species.

ENNOTHUS

Pascoc, Ann Nat Hist, (4), x, 1872, p. 87

Small, ovate. Head as in *Polycreta*, but slightly broader. Rostrum shorter, with dorsal surface broader, the internal ridges tuberculate at base. Eyes prominent, but less so than in *Polycreta*. Scape shorter. Prothorax tuberculate-dentate at the sides, the apical margin slightly produced, without ocular lobes, disc subplanate, granulate. Elytra ovate, broader than in *Polycreta*, base emarginate, humeral angles with a low crest not projecting forwards, disc granulate, with a few tubercles posteriorly, infra-humeral spine present. Posterior tarsi moderately elongate.

Genotype, *E. fallax* Pascoc

The original generic description consists of a few points of difference between *Ennothus* and *Acherres*. The genus however is much more closely related to *Polycreta*, and I have grave doubts as to whether it should be maintained as distinct. The main differences are the shorter and broader rostrum, the shorter scape and some differences in the prothoracic and elytral sculpture. There is moreover an undescribed species in the British Museum which might with equal propriety be referred to either genus.

ENNOTHUS FALLAX Pasc

Pascoc, Ann Nat Hist, (4), x, 1872, p. 87

Elongate-ovate, small. Clothing discoloured apparently uniformly brown.

Head broad, flattened, with faint traces of two longitudinal ridges, supra-ocular margins feebly raised. Eyes prominent, subrotundate. Rostrum comparatively broader and shorter than in *Polycreta*, the width across the upper

surface nearly equal to the total width of rostrum; upper surface very lightly depressed in middle, with a small denticulate crest at each side of base, situated to the inner side of the lateral margins. Scape moderately long, comparatively slender, shorter than in *Polycreta*. Prothorax not greatly dilated, apical margin hardly produced, ocular lobes absent, lateral margin with a small spicule posterior to middle and two smaller ones anterior to middle, median line hardly depressed, with a couple of small projections on each side near apex, and one about the middle, the rest of the surface apparently with a few obscure granules. Elytra suboval, strongly rounded on sides, base feebly emarginate, humeral angles not produced, disc with small obscure punctures, first interstice slightly raised, ending in a slight thickening, hardly a tubercle, at commencement of declivity, second with one or two granular tubercles above declivity, third with a row of small tubercles, granular at base, larger posteriorly, but always very small, the apical one at beginning of declivity, fifth with a humeral row of about 4 spicules forming a slight crest, thence with a row of small tubercles similar to those on third, infra-humeral tubercle spiculate, followed by a row of small spiculate granules. Under surface with base of abdomen gently convex, female genitalia extruded. Tarsi similar to *Polycreta*. Dimensions 3 lines (Pascoe).

Hab --- Western Australia

The above description was drawn up from the type in the British Museum. I am indebted to Mr A. M. Lea for a specimen, which I compared with the type, it also is without locality label. Another specimen in Mr Lea's collection from Bunbury probably belongs to this species, but is in a bad state of preservation.

ACHERRES

Pascoe, Ann Nat Hist, (4), x, 1872, p. 87

Small, ovate. Head convex. Rostrum short, thick, slightly narrowed to base, upper surface with internal ridges strongly raised into a prominent crest overhanging each eye, external margins low, clypeal plate exerted, facing forwards, submental margin almost straight, scrobes feebly curved almost reaching eyes. Antennae short. Eyes subrotundate, finely faceted. Prothorax much narrower than elytra, rounded on sides, apical margin subtruncate above, without ocular lobes, upper surface strongly convex from side to side, set with relatively large umbilicate rounded granules. Elytra ovoid, greatly widened on the sides, base emarginate, humeral angles marked, but not greatly produced, interstices tuberculate or granulate. Ventral surface flattened. Legs moderately long, tarsal joints comparatively short, the posterior slightly longer.

Genotype, *A. mamillatus* Pascoe

This genus in its rostral structure shows some relation to *Ochtesus*, though the crests are different in shape, the form of the prothorax is however altogether different, and is indeed unlike any other genus in the group.

Acherres was formed in 1872 for a single species—*A. mamillatus*, Lea in 1903 described a second species—*globicollis*, and in 1915 three species—*latus*, *pilosus* and *granulatus*—were added by myself. Of these *A. latus* may prove to be merely a large variety of *A. mamillatus*, but the others possess distinctive characters.

Table of Species

1	(6)	Elytral interstices tuberculate	
2	(5)	First and second interstices separate at base	
3	(4)	Smaller species with tubercles conical	<i>A. mamillatus</i> Pasc
4	(3)	Larger broader species with tubercles more debased	<i>A. latus</i> Ferg
5	(2)	First and third interstices conjoined at base	<i>A. globicollis</i> Lea
6	(1)	Elytral interstices granulate	
7	(8)	Setae short	<i>A. granulatus</i> Ferg
8	(7)	Setae long, piliform	<i>A. pilosus</i> Ferg

ACHERRES MAMILLATUS Pasc

Pascoe, Ann Nat Hist, 1872, p. 87, t 1, fig 5

Small, ovate Black, practically destitute of clothing, setae short, black

Head strongly convex, separated from rostrum by a deep transverse sulcus. Rostrum as wide as head at apex, narrower at base, upper surface rising at base into two conspicuous divergent crests, overhanging the eyes, with moderately large punctures. Scrobes little curved, extending almost to eyes. Eyes rotundate. Scape moderately long and thick, funicle with all the joints short. Prothorax narrow, hardly rounded, almost parallel-sided, apex not produced above, without ocular lobes, disc strongly convex antero-posteriorly and from side to side, median line impressed, closely set with large mamillate, umbilicate granules. Sides with similar granules. Elytra strongly ovate, much wider than prothorax, base emarginate with moderately advanced humeral angles, disc somewhat depressed, with rows of moderately large punctures and rows of umbilicate granules or tubercles, first interstice not joining third at base, with a single row of rather depressed, umbilicate, granules, obsolete posteriorly, second interstice with one or two similar granules, third interstice with a row of about 8 elevations, at base composed of groups of two or three umbilicate granules, becoming larger posteriorly and the last 2-3 tuberculiform, multipunctate, the last much the largest, overhanging declivity, fifth interstice with 6-7 smaller, almost spiniform, tubercles, larger posteriorly, multipunctate, seventh interstice with a single acute infra-humeral tubercle. Sides with deep foveiform punctures. Ventral surface hardly convex, without punctures, apical segment with a raised hirsute prominence. Legs simple, tarsi comparatively short. Dimensions 9 x 5 mm.

Hab—Western Australia. Geraldton

The sex distinctions in this genus are not well marked and short of dissecting a specimen it is difficult to be sure whether it is male or female.

The species is close to *A. latus* Ferg, but as a rule smaller with somewhat different tubercles.

ACHERRES LATUS Ferg

Ferguson, Trans Roy Soc S Aust, xxxix, 1915, p 83

This should perhaps be considered as a variety of *A. mamillatus* Pasc, rather than as a distinct species.

Hab—Western Australia. Cue, Lake Austin

ACHERRES GLOBICOLLIS Lea

Lea, Trans Roy Soc S Aust, xxvii, 1903, p 114

This species may be readily distinguished from the other members of the genus by the fact that the first and third interstices are conjoined at the base. The elytral tubercles appear subject to a considerable degree of variation in their size and development.

Hab—Western Australia. Swan River, Perth, Jandakot

ACHERRES GRANULATUS Ferg

Ferguson, Trans Roy Soc S Aust, xxxix, 1915, p 84

Hab—South Australia Tarcoola

ACHERRES PILOSUS Ferg

Ferguson, Trans Roy Soc S Aust, xxxix, 1915, p 84

Hab—Western Australia Cue

These two species are distinguished from the other members of the genus by the absence of elytral tubercles. They may be separated *inter se* by the nature of the setae, and by the differences in the elytral granules.

AMORPHORHINUS

— Lacordaire, Gen Coleopt, vi, 1863, p 318

Small, oblongate. Head depressed in front, with well-marked supra-ocular tubercles. Rostrum short and broad, upper surface depressed in middle with raised internal ridges, the lateral margins well marked, somewhat divergent at base, clypeal plate exerted, facing downward and forwards, submentum, almost straight, scrobes strongly curved, almost reaching eyes. Antennae short, scape short, funicular joints short. Eyes ovate finely faceted. Prothorax angulo-tuberculate on sides, apical margin hardly produced above, with strong ocular lobes, pronotum with median area depressed, bounded on each side by a well-marked ridge, with a sublateral ridge on anterior half between admedian ridge and lateral angle, sides more or less granulate. Prosternum rather strongly concave with a distinct tubercle on each side (except in *A. rugicollis*). Elytra more or less parallel sided or slightly widened posteriorly, the sides suddenly narrowed before apex, base deeply emarginate, the humeral angles strongly produced and cristaform, disc with third and fifth interstices tuberculate or subcostate. Ventral surface flattened in ♂, convex in ♀. Legs comparatively short, the posterior tarsal joints more elongate than the others.

Genotype, *Brachyocerus australis* Germar

The affinities of this rather remarkable genus are not very obvious, in the structure of the rostrum some relation to *Euomus* is suggested, but the clypeal plate is more strongly exerted and in other respects, e.g., the supraorbital crests, form of prothorax and elytra and general shape, it differs widely from that genus. At the same time it does not appear allied to any other known genus of the group.

Lacordaire laid stress on the excavation of the prosternum in separating the genus, but in one species (*rugicollis* Lea, originally described as a *Sosytelus*) the prosternum is not at all concave, though in other respects this species does not seem separable from the genus.

Some of the species are variable in structure and it is uncertain how far variation should be held to extend particularly in cases where forms in different localities are constant in each locality but differ from those of another. In some of these instances in the present paper I have thought it wise to attach specific or subspecific names to the different forms. More information is however required about the Western Australian species which show marked variation in structure.

Amorphorhinus was erected by Lacordaire in 1863 for the reception of

Brachycerus australis Germar Pascoe added a second species—*polyacanthus*—in 1870, and a third—*arcanus*—in 1882 In 1915 I described a species—*muriceus*—which I now regard as merely a variation of *A. polyacanthus* Pasc

In 1895 Lea described a species of *Sosytelus*—*rugicollis*—which I here place in *Amorphorhinus* Names are also attached to two forms which might be regarded as distinct species or as geographical races of *A. australis* Germar

Table of Species

- | | | | |
|----|------|--|------------------------------|
| 1 | (8) | Infra-humeral tubercle absent. | |
| 2 | (7) | Third and fifth interstices tuberculate | |
| 3 | (6) | Elytral tubercles erect, subconical | |
| 4 | (5) | Large species, with basal tubercles on third interstice confluent to form a distinct ridge | <i>A. tuberculatus</i> , nsp |
| 5 | (4) | Smaller species, with basal tubercles somewhat irregularly placed, but not confluent | <i>A. australis</i> Germ |
| 6 | (3) | Elytral tubercles obtusely rounded, less conspicuous | <i>A. oblitteratus</i> , nsp |
| 7 | (2) | Third and fifth elytral interstices subcostate | <i>A. rugicollis</i> Lea |
| 8 | (1) | Infra-humeral tubercle present | |
| 9 | (10) | Elytral interstices tuberculate | <i>A. polyacanthus</i> Pasc. |
| 10 | (9) | Elytral interstices granulate, the third interstice subfasciculate | <i>A. arcanus</i> Pasc |

AMORPHORHINUS AUSTRALIS Germ

Brachycerus australis, Germar, Linn Ent, iii, 1848, p 209 —*Amorphorhinus* id, Lacordaire, Gen Coleop Atlas, vii, t 67, fig 6a-b.

Small, oblongate Black, more or less densely clothed with greyish brown subpubescence

Head convex, forehead flattened, with several irregular longitudinal ridges, not conspicuous and variable, supraocular crests present, large Rostrum short, with the upper surface depressed in the basal half, internal ridges short, elevated, strongly convergent, external margins depressed at base Scape very short, funicular joints short, the first slightly longer than the others Eyes finely faceted. Prothorax strongly convex, the lateral margins strongly tuberculate-angulate in the middle, apex subtruncate above, with well marked postocular lobes, upper surface subplanate, with rather broad and somewhat irregular median and sublateral longitudinal impressions, the median area widest in the middle, bounded on each side by a raised ridge, set with small semi-confluent umbilicate granules; a similar ridge situated between the sublateral impression and the lateral margin in the apical half only Elytra suboblongate, very gently rounded on the sides; apex abruptly rounded; base deeply emarginate, with strongly advanced, somewhat inverted humeral angles, the bases of the third interstices advanced to a less extent and also inverted, disc with rows of rather deep, moderately regular rounded punctures, third and fifth interstices raised and tuberculate, the third incurved at base and towards declivity, with a row of small nodulose tubercles, smaller at base, longer posteriorly, ending at edge of declivity, the penultimate tubercle the largest, fifth interstice with a row of about 9 small tubercles extending along the outer side of the humeral crest and along the interstice to end in a much larger tubercle at level of declivity, lateral interstices non-granulate, infra-humeral tubercle absent Prosternum widely concave in centre, with a small tubercle on each side Ventral segments more or less flattened. *Dimensions* · ♂. 8.9 x 4 mm

Hab—South Australia Ardrossan; Queensland: Mackay

I have identified the above with *A. australis* as of the two forms which occur in South Australia, this one agrees best with Germar's description.

The name *A. australis* is however commonly employed to cover all the eastern forms of *Amorphorhinus* except *rugicollis* Lea. It was recognised that the species was variable but the material available indicates that the name has been used to cover either several distinct species or else geographical races. I have however only specimens from widely distant localities, and these appear sufficiently distinct to describe. Specimens are however required from intervening districts in order to ascertain whether there are any intergrading forms. It is noteworthy that specimens in Mr Lea's collection labelled as from Mackay, Queensland, are indistinguishable from the typical South Australian form. I am uncertain of the range in the latter State, as Ardrossan and Lucindale are the only localities definitely fixed for the species, other specimens that I have seen being merely labelled South Australia; in the eastern portion of the State however the next species (or subspecies) occurs. In the Australian Museum there are a number of specimens of this species brought back by Mitchell's Expedition to the Victoria River.

AMORPHORHINUS TUBEROLATUS, n sp

Similar to *A. australis* Germ., but larger with stronger tubercles. Black, with somewhat sparse brown subsetose clothing.

Head and rostrum similar to *A. australis*, but ridges and supraocular crests more marked. Prothorax with ridges more elevated and granules larger. Elytra with humeral crests projecting much more strongly outwards and forwards, the free margin lined by a row of large granules or small tubercles, third interstice with a row of large erect subconical tubercles, pluripunctate, those at base fused to form a short oblique ridge, directed inwards and forwards, fifth interstice with a row of 4-6 strong conical tubercles from behind humeral crest to declivity, the last much larger and obtuse. Legs and ventral surface as in *A. australis*. Dimensions. 10-11 x 5 mm.

Hab - South Australia. Maramba, Karoonda.

Three specimens are before me, all apparently females, the chief differences from *A. australis* lie in the larger size and the greater development of all the structural characters. It is probably an eastern form of *A. australis*, but my records of the range of that species are very incomplete.

AMORPHORHINUS OBLITRATUS, n sp or subsp

Larger than *A. australis*, but with less well defined tubercles. Black, rather densely clothed with brown subsquamose pubescence.

Head similar, but more irregularly and rugosely ridged, rostrum as in *A. australis*. Prothorax with lateral angles more obtuse, not acutely tuberculate, ridges on disc lower, broader, with granules almost completely fused. Elytra with humeral angles advanced but not projecting laterally, hardly interrupting the line of the lateral margin, third interstice raised, in the form of a somewhat tortuous ridge in the basal half, followed by 8 isolated, obtuse, nodulose tubercles, fifth interstice with a row of obtuse granules along outer border of humeral crests, continued on as a row of small obtuse tubercles, of which 4-5 are distinct and the remainder fused to form an elongate tubercle corresponding in position to the large tubercle in *A. australis* and one or two of those immediately before it. Other structures as in *A. australis*. Dimensions. 10 x 4.5 mm.

Hab—N S Wales Muswellbrook

Differs from *A. australis* in the less developed, more obtuse tubercles, the structure of the third interstices being much confused and difficult to describe. Two specimens are now before me, but I have seen others from the same locality.

Two specimens from Bell in South-eastern Queensland differ somewhat from the above description in that while the same tendency to fusion exists, the structures are better defined and the individual tubercles rather larger though obtuse.

AMORPHORHINUS POLYACANTHUS Pascoe

Pascoe, Journ. Linn. Soc., xi, 1873, p. 454—*A. muriceus* Ferguson, Trans. Roy. Soc. S. Aust., xxxix, 1915, p. 85.

Since my description of *A. muriceus* was published I have had the opportunity of examining many more specimens, including the type of *A. polyacanthus* in the British Museum. I now consider that all these specimens should be referred to but one species—*polyacanthus*—which is extremely variable in the size and development of the elytral tubercles. The differences in clothing appear to be due to the abrasion or discolouration of specimens which are old or rubbed, fresh specimens irrespective of the development of the elytral tubercles are clothed as described under *muriceus*.

Hab—Western Australia Swan River District, Beverley, Darling Ranges

AMORPHORHINUS ARCANUS Pascoe

Pascoe, Ann. Nat. Hist., (5), ix, 1882, p. 379.

Elongate ovate, small. Black, densely clothed with chocolate brown subpubescence in fresh specimens (type abraded and muddy).

Head convex, tri-impressed in front, with two longitudinal ridges and a somewhat obsolete projection, not conical nor conspicuous over eye. Rostrum short, broad, separated from head by a somewhat ill-defined impression, anterior portion of dorsal surface not raised, with a median ridge bifurcate anteriorly, the apical plate lying in the fork, basal half depressed in middle, with a ridge on either side, these ridges almost immediately bifurcated, the inner portion extending straight back to the ends of the ridges on the head, the outer ridge diverging outwards to meet the supraorbital crests, space between branches shallowly depressed, in each case the rostral ridges separated from the corresponding head ridges by a slight impression. Antennae with scape short, greatly incrassate at apex. Prothorax transverse, apical margin truncate above, with moderately prominent ocular lobes, lateral margins angulate in middle, with small granules extending from base outwards to angle and thence inwards to ocular lobes, disc with a rather irregular and ill-defined subapical impression, and a broad moderately deep median impression, somewhat unevenly set with somewhat depressed granules of moderate size, sides granulate. Elytra gradually widened, abruptly narrowed before apex, base deeply emarginate, humeral angles cristaform, projecting forwards, third interstices raised, slightly produced forwards at base, with a row of granules, small and closely placed at base, slightly larger and irregularly placed posteriorly, in unabraded specimens with 3-4 fasciculate elevations composed of upright setae and short stout subsetose pubescence, fifth interstices with a row of granules along outer edge of humeral crest, also with granules along interstices, forming a distinct row on posterior portion, but somewhat confused and apparently in double series on middle of interstices, the pos-

terior ends of both third and fifth interstices incurved, seventh interstice with prominent infra-humeral tubercle, the outer margin set with three or four granules. Sides with rows of small punctures, interstices non-granulate. Under surface slightly convex at base, moderately densely clothed with yellowish-brown pubescence, punctures small, obscured in type, slightly on apical segment. Propodeus with a slight nodule in front of anterior coxae, gently concave between. *Dimensions* 8.5 x 4 mm.

Hab — Western Australia. Swan River.

Of this species I have examined the type and another specimen in the British Museum. The species is allied to *A. polyacanthus* Pasc. but is distinguished by the less prominent sub-obsolete supraocular crests, the granulate, not tuberculate elytra and the multigranulate infra-humeral spine. The fasciculate quasi-tubercles on the third interstice are also distinctive, but are subject to abrasion.

AMORPHORHINUS RUGICOLLIS Lea

Sosytelus rugicollis Lea, Proc. Linn. Soc. N. S. Wales, xx, 1895, p. 305.

The species described by Lea as *Sosytelus rugicollis* cannot be allowed to remain in that genus. Despite the difference in the elytral sculpture, costate instead of tuberculate, the species seems undoubtedly to belong to *Amorphorhinus*. The structure of the rostrum and the well developed supraocular crests associate it with the latter genus. I might add that Pascoe evidently considered the species to belong here, as there is a specimen in the British Museum labelled by Pascoe with a manuscript name as a new species of *Amorphorhinus*.

Hab — N. S. Wales. Rooty Hill, Queanbeyan, Cootamundra.

STUDIES IN SYMBIOSIS.

V A CONTRIBUTION TO THE PHYSIOLOGY OF *GASTRODIA SESAMOIDES* (R Br)

By JOHN McLUCKIE, M A , D Sc , Lecturer in Plant Physiology,
University of Sydney

(Sixteen Text-figures)

[Read 29th August, 1923.]

General Description

Gastrodia is a small genus of the Orchidales, which is mainly confined to the East Indian Archipelago, but extends throughout Australasia. Only one species, namely *G. sesamoides*, is endemic to Australia, but two species occur in New Zealand.

G. sesamoides has been recorded from Queensland, where it has been found in the neighbourhood of Brisbane, from the Coastal region and Blue Mountain Plateau of New South Wales, and from Tasmania and Victoria. Some of the material for this investigation was collected at Mt Wilson, New South Wales, where it was found on the rich, loose, basalt which caps Mt Wilson and its neighbours, Mt Tomah and Mt Irvine. The basaltic soil is of a rich chocolate colour and retains the moisture well. It extends down the slopes of many valleys and gullies in the neighbourhood, and supports a marvellously dense and luxuriant flora, which contrasts in a remarkable manner with the sandstone flora near by.

Other material of *Gastrodia sesamoides* was collected at Russell Falls in Tasmania. The entire plants in this case were smaller than those from Mt Wilson, and the rhizomes were very much smaller. No roots were present on this material when collected.

Gastrodia sesamoides has a thick, fleshy, succulent rhizome, covered at intervals with thin, scaly, membranous leaves; small hairs also occur on the surface, and there is no well developed corky tissue. From the end of the rhizome a flowering axis is developed which may attain a height of 18 inches. It is slightly succulent, brown in colour, and has a few, sheathing, membranous, scaly leaves. There is no chlorophyll in any part of the body. The rhizome frequently forms several buds which may develop as flowering shoots, but generally remain dormant.

When the material was collected, just before the flowers opened, I could find no trace whatever of roots, complete rhizomes were removed and placed in flowerpots in the Sydney University garden. The plants flowered in November and the flower-axis withered away. The plants were left undisturbed until the 3rd February following, and were then examined. It was observed that each rhizome had developed one or several long thin roots (Text-figs 1a, 1b.)

Rodway (Tasmanian Flora) states that *Gastrodia sesamoides* is "parasitic" possibly on small roots of trees, but I have obtained no evidence of parasitism on other roots, the leafless, non-chlorophyllous habit of the plant has probably prompted this assumption, but my investigations of this very remarkable orchid do not support the hypothesis of parasitism upon the roots of other plants. As I shall demonstrate in a subsequent part of this paper the rhizome of this orchid is inhabited by a mycorrhizic fungus and by bacteria which live symbiotically

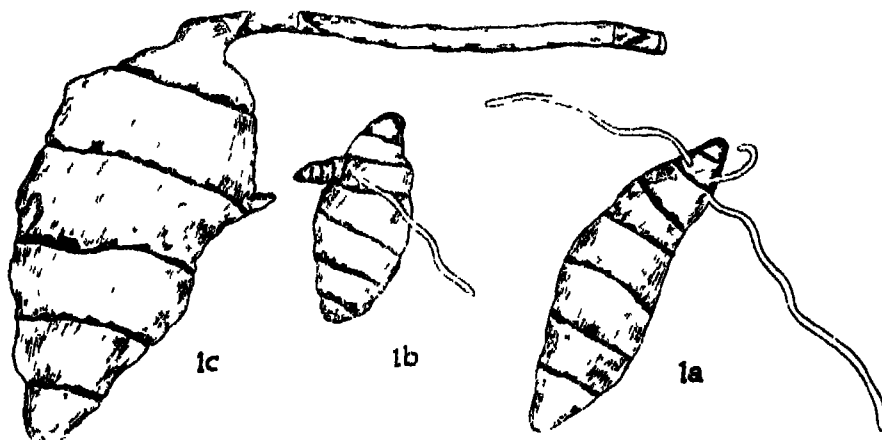


Fig 1 Rhizome of *Gastrodia* Scale leaves roots, flowering axis (2')

within its tissues without causing any obvious injury, and probably contributing material benefits to the plant which, in the absence of chlorophyll, must be heterotrophic. *Gastrodia sesamoides* is another example of the phenomenon of "Symbiotic saprophytism" among the higher plants.

Structure of rhizome

Gastrodia hibernates by means of a thick, fleshy, succulent, tuberous rhizome which may vary in thickness from $\frac{1}{4}$ inch to approximately 2 inches. At times it somewhat resembles a Dahlia tuber in general external appearance (Text-fig. 1c). In transverse section (Text-fig. 2) it is seen that it is protected externally by two or three layers of small, slightly suberised cells with brownish walls, from some of which occasional short hairs are developed. This zone represents a sheath, and is devoid of protoplasmic contents. The rest of the rhizome consists of large, thin-walled cells forming the ground tissue, in which are situated the small vascular bundles arranged in the typical monocotyledonous fashion. The entire rhizome is soft and succulent, and very easily broken. Large intercellular spaces occur amongst the cells of the ground tissue. Many of the outer cells just within the sheath contain tangled groups of fungal hyphae of very coarse texture. These hyphae are non-septate and have extraordinarily thick walls and sparse protoplasmic contents (Text-fig. 3). The hyphae branch frequently within the cells, and are somewhat irregular in diameter (Text-fig. 3a, 3b). Their walls are also unevenly thickened. Certain hyphae become considerably swollen at one end and charged with protoplasm. The swollen hyphae

resemble the sporangioles of other authors. The hyphae pass from cell to cell by dissolving a small pore in the dividing wall of the host-cells, and portion of the wall is pushed up in the form of an enveloping sheath in the direction of growth of the hyphae (Text-fig 4). A somewhat similar sheath has been observed by Jeffrey (1896) in the case of the fungus infecting the prothallus of *Botrychium virginianum*, and by Lang (1899) in the endophytic fungus of *Lycopodium clavatum*. By examining the direction of formation of these sheaths

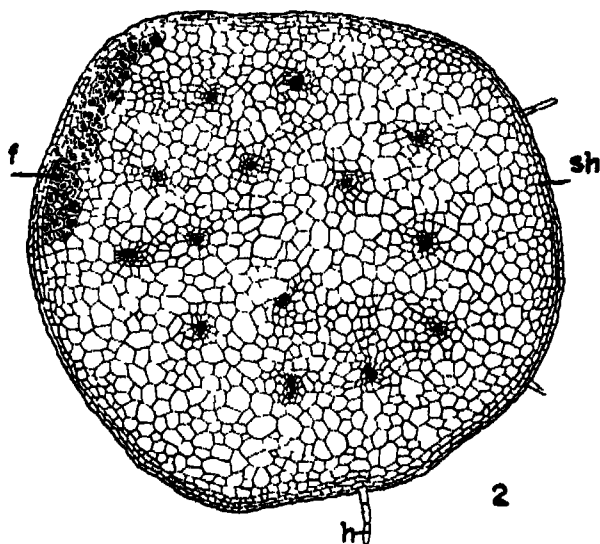


Fig 2 TS of rhizome showing typical monocotyledonous structure, sheath (sh) hairs (h), mycorrhizic fungus (f) (x 13)

it is possible to trace the line of infection. Frequently groups of hyphae occur on the surface of the rhizome, projecting into the surrounding soil, or growing inwards to the host-cells. The hyphae do not remain in the sheath-cells which contain no starch or protoplasm, but pass into the large and highly nourished cells of the ground tissue.

The Fungus of Gastrodia

This mycorrhizic fungus is not very abundant in the rhizomes of *Gastrodia sesamoides*, and only occurs in small isolated patches in the outer cells of the ground tissue.

It would therefore appear that the host does not depend entirely upon the symbiotic fungus for its nutrition, although no doubt the fungus does perform some work for the host, at any rate, the host-cells do not suffer any obvious injury from the presence of the fungus. In some of the cells of the fungus-infected zone, numerous spore-like bodies with spiny walls are present and are apparently formed by the fungus (Text-fig 3c).

The fungal hyphae inhabiting certain of the outermost cells of the rhizome occupy approximately two-thirds of the cell volume, and in all the hundreds of cells I have examined there was no suggestion of disorganisation or digestion of

the fungus by the cell contents. This condition is quite different from that of the mycorrhizic fungus of *Dipodum punctatum* (McLuckie, 1922) and many other plants described by other authors. From such an observation it would seem that the host-cells inhabited by the fungus derive their organic food materials directly from the metabolic processes of the fungus, and not indirectly by the digestion and assimilation of its body. The cells of *Gastrodia sesamoides* do not behave like phagocytes as in *Dipodum*, but maintain a relationship with the fungus comparable to that between an ectotrophic fungus and its host. The nucleus of the fungus-infected cells is larger than that of the uninfected, and the

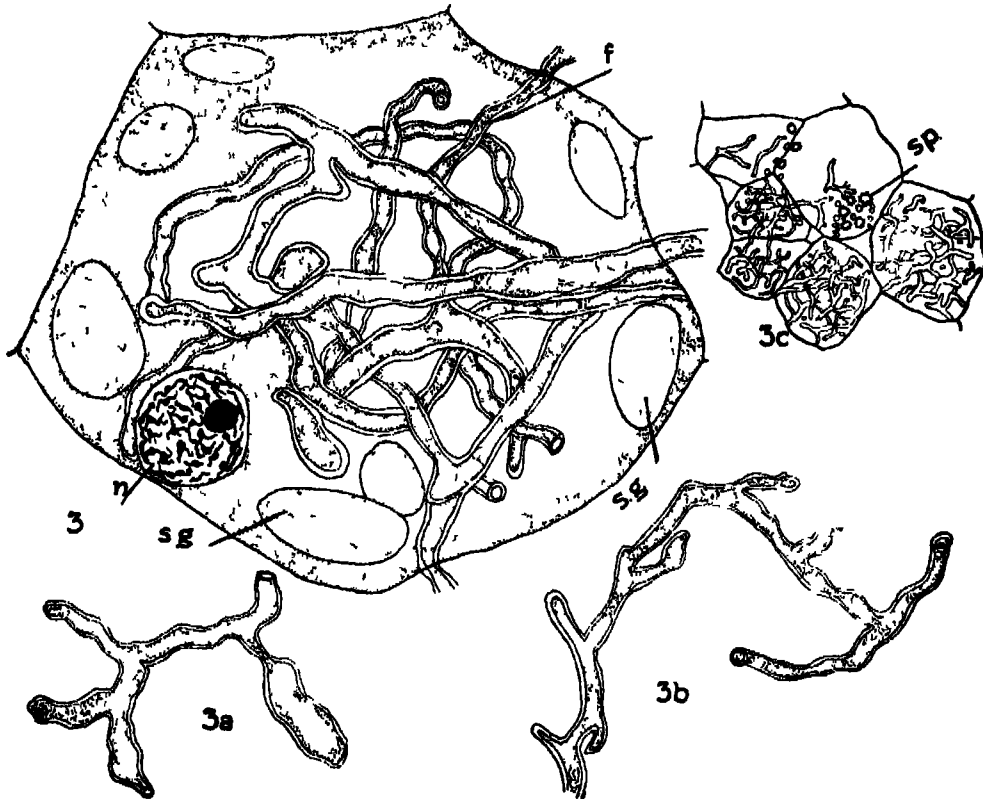


Fig 3 Cell of rhizome containing a tangled mass of fungal hyphae, nucleus (n) starch grains (sg) (x 600)

Figs 3a, 3b Portions of fungal hyphae showing the thick walls and the large vacuoles (x 600)

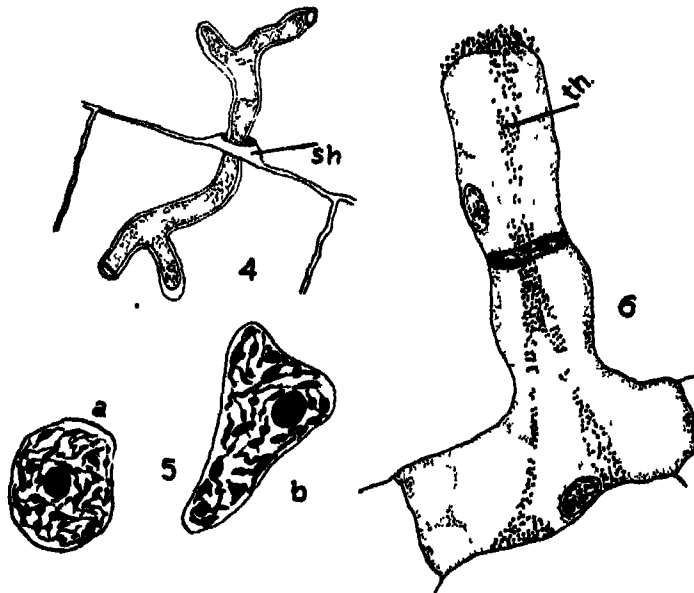
Fig 3c Cell of rhizome containing a fungal mass and spore-like bodies with spiny walls (sp) (x 60)

chromatin is very granular (Text-figs 5a, 5b). The form varies from spindle-shaped to spherical. I have not observed any fragmentation of the nucleus as McDougall (1899) has described in *Peramium repens*, and Dungeard and Armand (1898) in *Ophrys*, nor have I seen any certain example of cell-multiplication as recorded by McDougall, and caused by the presence of the fungus.

The presence of an endophytic fungus in a rhizome has been recorded by Frank (1892), and McDougall (1899) in his description of *Peramium* states that the hyphae find their way a short distance into the stem. In *Gastrodia* there can be no doubt about the mycorrhizic fungus being present in the rhizome while bacteria occur in roots, rhizomes and base of flowering shoot

Kusano's work on G elata

S Kusano (1911) has investigated *Gastrodia elata* and its mycorrhiza, only a preliminary account of which I have seen, and the results of his investigations are interesting by way of comparison with the species which forms the subject of this paper, namely, *Gastrodia sesamoides*. According to Kusano the vegetative organ of *Gastrodia elata* is represented simply by a tuberous rhizome which forms a mycorrhiza with the mycelium of an Agaric which he has identified as *Armillaria mellea*. The mycelium lives endophytically in the cells of the rhizome while direct



- Fig 4 Hyphae passing from one cell to another, and causing the cell wall to be softened and pushed up as a sheath (x 600)
 Fig 5 Nuclei of fungal infected cells showing irregularities of form and exceedingly granular chromatin (x 600)
 Fig 6 Hair from rhizome showing threads of bacteria (th) passing along it into the sheath-cells (x 600)

connection is maintained with the rhizomorpha strands vigorously vegetating in the surrounding medium. Infection by the fungus is effected by a sucker-like branch of the rhizomorpha strand penetrating the cortical cells of the tuber, partly compressing the cells and dissolving the cell walls. He compared this process of penetration to that of the haustorium of *Cuscuta*. From the infecting strand separate hyphae spread intracellularly in a definite zone under a few layers of cortical cells. He distinguished three mycorrhizal cell-layers in the in-

fects rhizome, namely, (a) an outer region of two or three cell-layers containing a densely tangled mass of comparatively thick-walled hyphae, (b) a median zone of one or two cell-layers containing tangled masses of thin-walled hyphae of variable diameter, (c) an inner zone composed of large cells with a few slender less regular hyphae

The hyphae of the second zone undergo "self-disorganisation," leaving their walls as irregular masses, while in the inner zone the hyphae are consumed by the host-cells

Kusano has described very considerable changes within the mycorrhizal cells of *Gastrodia elata*. The protoplast of cells of the second region is soon consumed by the fungus, while in the outer region the hyphae are invested by the cytoplasm of the host-cell. Stretching and fragmentation of the nucleus may take place. In the inner zone of mycorrhizal cells the cytoplasm becomes very dense and granular, while the nucleus undergoes hypertrophy and deformation. The cells of this region contain "chemical bodies" which the author interpreted as secretion and excretion products of the endophyte

The author concluded that "the reciprocal exchange of nutritive substances between the two organisms is not equal," that the fungus is the victim of the orchid, which lives parasitically upon it

The Bacteria of G. sesamoides

When the rhizomes were broken across and pressed, a whitish, watery sap exuded from the cut surface. A drop of this solution was mounted on a slide and examination revealed the presence of immense numbers of bacteria, amongst large spindle-shaped or oval starch grains. The starch grains, when treated with iodine, gave the pinkish colouration which is so common in saprophytic Angiosperms (Text-fig 7)

Microtome sections of the rhizome were stained in weak Carbol-Fuchsin, and in Carbol-Gentian Violet, Lugol's Iodine and Safranin, and Gentian Violet, Lugol's Iodine and Erythrosin, and examined for the bacteria. It was found that practically every cell of the ground tissue contained large masses of bacteria and numerous large starch grains in addition to the protoplasm and nucleus (Text-figs 8, 9, 10). In sections of the fresh rhizome the bacteria showed active movement within the cells. Sometimes the bacteria were massed around the nucleus, or in the vicinity of starch grains, in other cells they were more uniformly distributed throughout the lumen. None of the cells of the rhizome appeared to suffer the slightest injury from the presence of the bacteria and, with the exception perhaps of enlarged cells and intercellular spaces, there was no obvious pathological effect in the tissue. From a careful examination it appears that the bacteria and host form a mutualistic association.

Pure cultures of the bacteria were made by transferring them from the interior of the cut rhizome (the surface of which had been washed in a sterilising fluid)* to a nutritive agar medium in test-tubes and petrie dishes and incubating at a temperature of 26°C. In the course of 48 hours very vigorous colonies were developed

* The sterilising fluid (employed previously by Harrison and Barlow in the Leguminosae) had the following composition —Mercuric chloride 1 gram, hydrochloric acid 2.5 cc, distilled water 1000 cc

The bacteria were found in every part of the rhizome excepting the bundles, in the roots, and even in the basal portion of the flowering shoot

In regard to the method of infection of the rhizome by means of the bacteria, I have observed masses of these micro-organisms around the apex of the hairs and in several cases zoogloea-like threads of bacteria were seen within the

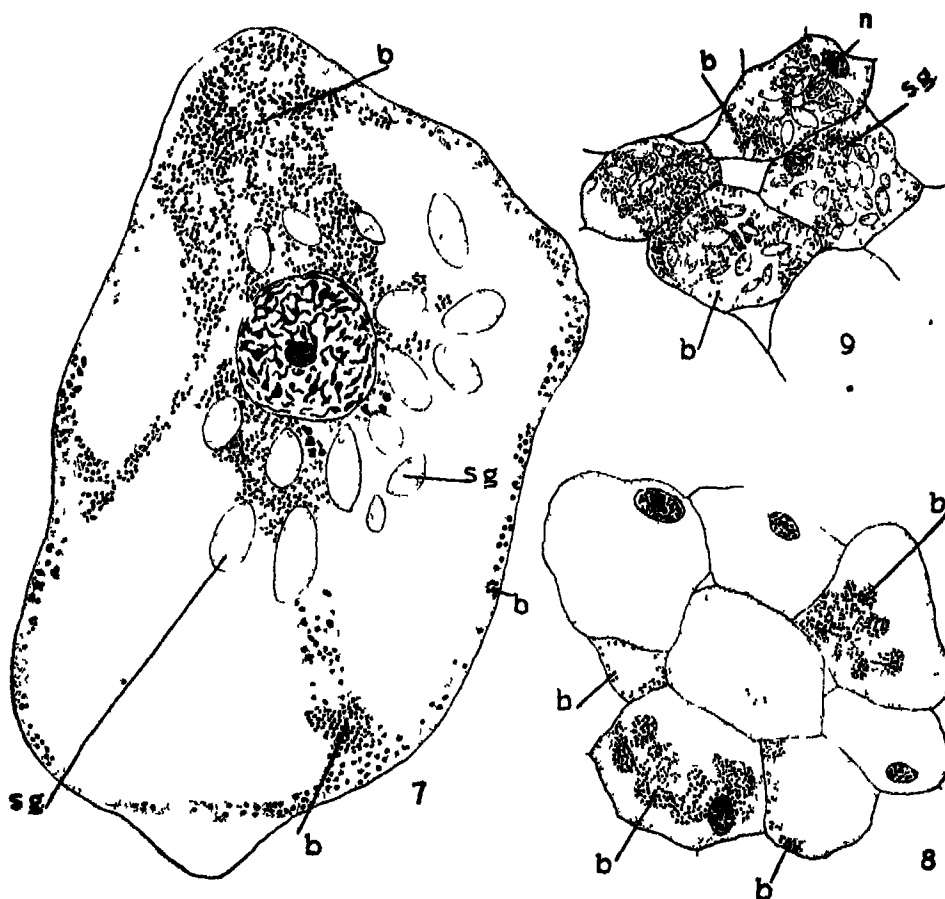
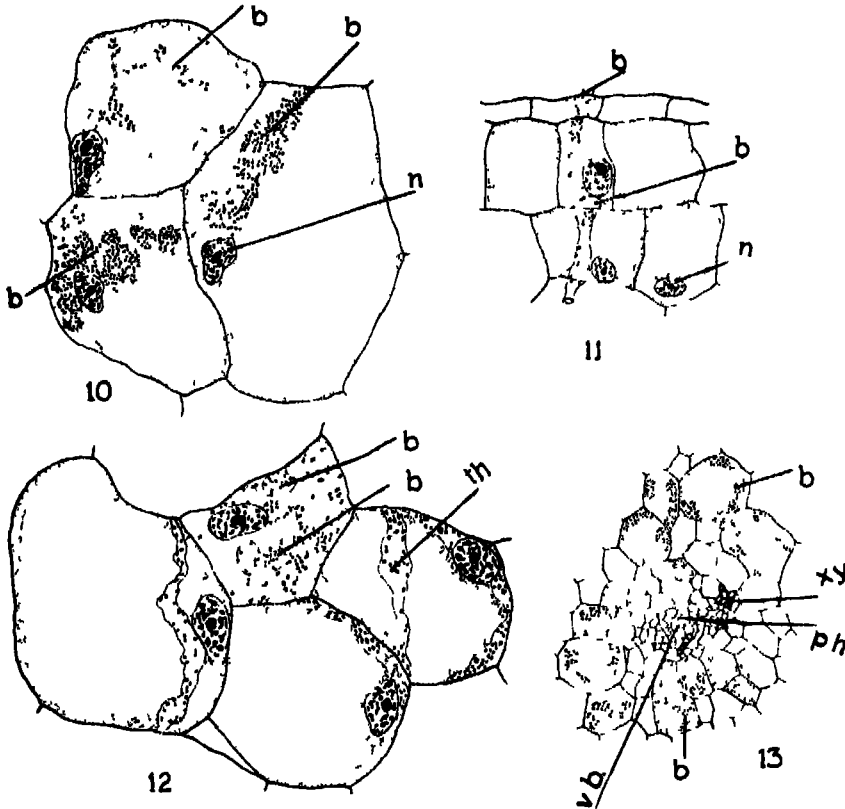


Fig 7 A cell of ground tissue showing threads of bacteria, nucleus, starch grains (sg) (x 600)

Figs 8 9 Groups of cells showing the irregular masses of bacteria (b) (x 267)

hairs Text-fig 6 shows how the bacteria enter the cells of the rhizome. I do not consider this the only method of infection for the hairs are not numerous, and I have observed masses of bacteria within slightly disrupted peripheral cells of the sheath in such a position as to suggest that infection may occur at any part of the surface of the rhizome Text-figure 11 shows one of the peripheral cells of the rhizome in the early stages of bacterial infection Inside the cell numerous bacteria are present and just outside this cell a mass of bacteria may be seen Threads of bacteria penetrate from the superficial cells

into cells more deeply seated, and in these enlarged cells the bacteria multiply very rapidly, forming peculiar masses or colonies enclosed within a gelatinous sheath. Text-figures 7, 8, 9, 12, 13, show late stages of infection. Cells which



- Fig 10 Group of cells showing the irregular masses of bacteria (b) (x 267)
 Fig 11 Portion of exterior of rhizome showing bacteria passing through the sheath-cells into the ground tissue beneath (x 267)
 Fig 12 Cells of ground tissue showing gelatinous bacterial threads passing from cell to cell (x 267)
 Fig 13 Vascular bundle of rhizome surrounded by bacterial cells (b) (x 267)

are infected by the bacteria become very large. Generally they possess a single nucleus, but several bi-nucleate cells were observed. The chromatin of the nucleus becomes exceedingly dense and granular.

Nitrogen fixation of Bacteria.

The bacteria were transferred from a pure nutritive turnip-agar-culture by means of a platinum loop to three flasks A1, A2, A3, of 500 cc capacity, containing 100 cc of the following nutrient solution—Cane sugar 10 grams, Potassium phosphate 1 gram, Magnesium sulphate 0.5 gram, Calcium carbonate

0.5 gram, Distilled water 1,000 c.c. The solution was neutralised with NaOH and sterilised.

The flasks were incubated at a temperature of 26°C. for 15 days. The contents became quite cloudy, owing to the rapid multiplication of the bacteria. Control flasks containing the same solution were inoculated and sterilised in the autoclave for two hours, and then incubated, but the solution remained quite clear.

The nitrogen content of the flasks was determined by the Kjeldahl method with the following results —

A1 7.8 mg

A2 6.1 mg

A3 6.85 mg

Average per flask, 6.916 mg

Since the amount of combined nitrogen introduced during inoculation with the bacteria is practically negligible, the nitrogen in the culture at the end of 15 days represents approximately the gain in nitrogen due to the activity of the bacteria which had been introduced. There must, therefore, have been a fixation of the free nitrogen of the flask by these micro-organisms during the processes of metabolism. What the bacteria accomplish in the nutrient solution of the flask, and with free nitrogen available, they no doubt accomplish in the cells of the host which are known to contain carbohydrate and to have access to the free nitrogen of the soil which circulates throughout the extensive intercellular space system of the rhizome and root. It appears to me that *Gastrodia sesamoides* is another example of a higher plant being assisted in its nutrition by micro-organisms of the soil invading its tissues, transforming the free nitrogen into an organic or colloidal form which may be assimilated in the metabolic processes of the host or providing the host with the humus and ash constituents.

Comparison of G. sesamoides with G. elata

Gastrodia sesamoides differs from *Gastrodia elata* in many important respects. Kusano does not mention roots upon the rhizome of his species, but these do develop from time to time upon *Gastrodia sesamoides*, but they have no root hairs.

In *G. sesamoides* an endophytic fungus is sparsely or intermittently present, it only occurs in small isolated areas, and is not distributed in definite zones as in *G. elata*. The fungus penetrates the outer cortical cells of the rhizome as separate strands, not as a complex rhizomorph, and spreads into cells around the centre of infection. The fungal hyphae are confined to the three or four superficial rows of cortical cells (Text-fig. 2). The fungal hyphae undergo no obvious disorganisation or digestion by the host cells, but the cytoplasm of the latter is partially destroyed, and the nuclei do not show any hypertrophy or deformity as Kusano has recorded for *Gastrodia elata*. The fungal hyphae communicate with others outside the rhizome, and while it is possible that they may absorb organic and inorganic matter for the host-cells, I am rather inclined to the view that the fungus is a parasitic intruder. At any rate the inter-relation of host and fungus appears to be different from many other cases of endophytic mycorrhiza in Angiosperms, where the host-cells apparently derive nitrogenous and probably carbohydrate foods from the digestion of the fungal body. Moreover, the physiological relationship of the mycorrhiza to the host suggests the ectotrophic condition of the *Epacridaceae* rather than the endophytic type of *Psilotum* (Shibata, 1902) or *Dipodium punctatum* (McLuekie, 1922).

But the outstanding difference in the nutrition of the two species, *G. elata* and *G. sesamoides*, lies in the presence of masses of bacteria in the latter and their absence from the former (as Kusano makes no mention of them). I am not aware of any existing record of the occurrence of bacteria in the body of a saprophytic Orchid, and it seems that *Gastrodia sesamoides* is so far unique in this respect. The bacteria occur in enormous numbers throughout the cells of the rhizome. They even enter the aerial flowering axis as it develops from the rhizome, in my specimens which developed roots, bacteria were found to be

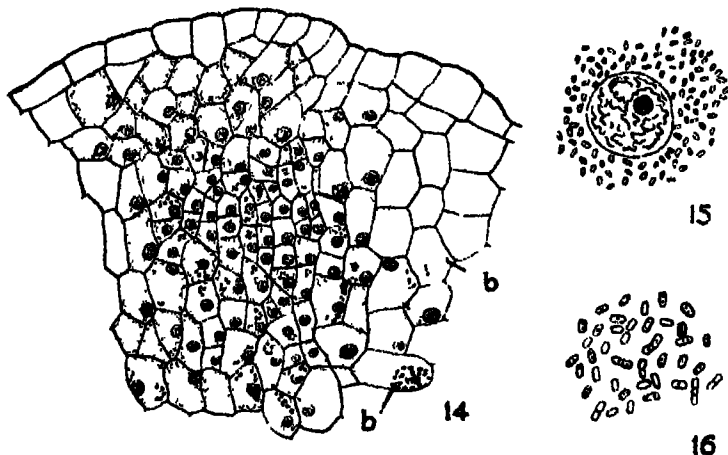


Fig 14 A group of meristematic cells which may develop into a lateral branch many of the cells contain small numbers of bacteria ($\times 267$)

Fig 15 A nucleus surrounded by a mass of bacteria ($\times 500$)

Fig 16 A group of bacteria ($\times 600$)

present. Here, however, they are not so numerous, nor so extensively distributed throughout the cells of the organ. They rather occur in isolated cells of the outer cortex.

Text-fig 14, shows a group of meristematic cells in the cortex of the rhizome, and practically every cell is infected with bacteria. There is nothing abnormal about these meristematic cells, either in regard to their cytoplasm or nuclei. The adjacent cortical cells also contain bacterial colonies. Such a meristematic group will probably develop into a bud or aerial shoot, which obviously is infected from its inception.

Text-figs 15 and 16 show the form of the bacteria, which are rod-shaped, and generally contain one to three small deeply staining granules. The organism of *Gastrodia sesamoides* closely resembles *Pseudomonas* of Leguminous tubercles.

The nutritive relation between the host and its endophytes

(a). *The function of the Fungus*

Gastrodia sesamoides, being leafless, reddish-brown in colour and devoid of chlorophyll is incapable of photosynthesis, according to the present state of our knowledge, it cannot utilise, directly, the solar energy for the synthesis of carbohydrates. It must therefore be heterotrophic in its nutrition—it must derive its carbon compounds from some other source than the CO_2 of the atmosphere. It

lives in association with a fungus and a bacterium. These organisms are domiciled in its tissues and, as a careful investigation of the plant reveals, do not cause the orchid the slightest injury.

The source of food materials to the orchid, is the soil, which contains the essential carbon, nitrogen, water and ash requirements of the higher plants. The carbon occurs as CO_2 or as more complex organic compounds in the humus, the nitrogen in the pure state in the soil-air, and as nitrates, ammonia and possibly proteid or amido-compounds in the humus. These may be absorbed by the plant directly, or obtained indirectly as the result of the metabolism of the fungus or the bacteria.

As the plant does not possess root-hairs, and as comparatively few hairs which might assist in absorption occur on the rhizome, it seems impossible to escape the conclusion that absorption is mainly dependent upon the fungal hyphae which dwell in the outer tissues of the rhizome and penetrate outwards to the soil. It is possible also that the surface cells of the rhizome and root may assist in absorption, but, as root-hairs of plants developing in a fungus-infested soil obtain the ash constituents and inorganic salts with difficulty, it is very probable that the superficial cells of root and rhizome, in a form practically devoid of these structures, are not at all efficient in this direction.

The mycorrhizic fungus associated with the rhizome, living in its cells and covering its surface in places, appears to me to constitute a most important factor in providing the orchid with the ash constituents necessary to the plant. Moreover, the heterotrophic nature of the fungal nutrition, makes it possible for this organism to obtain carbon compounds from the soil which, as a general rule, are not available to higher plants—although Acton has shown that certain higher plants can obtain carbonaceous food from the humus, etc. The main form in which carbohydrates occur in fungal organisms is glycogen, but the orchid contains abundant and large starch grains staining distinctly pinkish with iodine. The protoplasm of the orchid cells must have the capacity of either employing the organic carbon compounds absorbed from the soil humus directly, or of transforming the fungal glycogen to starch. The former alternative, in the light of Acton's researches, appears the more acceptable. It does not seem at all likely that either the fungus or the orchid can use the carbon dioxide of the soil air. As regards protein synthesis a supply of carbohydrates and of combined nitrogen in the form of nitrate or ammonia (and probably amido-nitrogen) are necessary. These may be utilised by the fungus to form proteids, or the higher plant may carry out this synthesis itself. While certain mycorrhizic fungi are suspected of fixing free nitrogen for higher plants, I am not at present in the position to state the capabilities of *Gastrodia* in this respect, but I intend investigating this possible property in a number of orchids and Epacridaceae possessing mycorrhiza.

If the fungus carries out the synthesis of the nitrogenous foods, then we might expect a digestion of the fungus by the host-cells, as is known to occur in such forms as *Dipodum punctatum* (McLuekie, 1922), *Periotum* (Shibata, 1902) and *Gastrodia elata* (Kusano, 1911), etc. In the present type, however, no such digestion has been seen, and it would therefore appear that the fungal hyphae function more in an ectotrophic manner than endotrophie, and that the higher plant is responsible for the synthesis of its own nitrogenous food.

For this purpose the carbohydrates, energy and combined nitrogen are available. The carbohydrates and nitrogen being provided by the fungus and the energy by the combustion of the carbohydrates during the respiration of the orchid cells.

(b) *The function of the bacteria.*

Experiments conducted with a view to testing the behaviour of the bacteria in regard to nitrogen fixation, revealed the important fact that they possess this property in a remarkable degree. Their capacity in this respect somewhat exceeds that of the organisms in *Podocarpus spinulosus*, *Casuarina Cunninghamiana* and *Macrozamia spiralis*, investigated by the author, and of *Cycas*, *Alnus*, *Eleagnus*, *Myrica Gale* investigated by Bottomley (1912) and Spratt (1912)

6.916 mg of free nitrogen were "fixed" or assimilated by the bacteria in the culture flask in 15 days, i.e., almost 0.5 mg per day. These estimates are probably higher under the uniformly favourable conditions of culture in regard to nutrition and temperature than in nature, but even in nature the conditions are such as to induce great activity in the fixation of nitrogen in Australian plants possessing nodules or tubercles or some such-like domatia for nitrogen fixing bacteria. The combined nitrogen formed by the bacteria is probably in the form of amido-nitrogen or proteids, and these are available to the cells of the higher plant by digestion of certain of the bacteria. It was observed that many cells contained small active individuals and larger and denser forms. The latter represent the bacteroids which constitute the main supply of the orchid as regards combined nitrogen.

From a study of *Gastrodia sesamoides* and of the fungal and bacterial organisms associated with it, I am convinced that an elaborate and remarkable symbiotic condition exists. The two endophytic organisms must provide the higher plant with its nutritive requirements in regard to carbon and nitrogen-containing compounds. The fungus inhabiting, as it does, some of the more superficial cells of the rhizome, and penetrating outwards to the soil, may conceivably provide water, ash constituents, and carbonaceous substances, perhaps also combined nitrogen, e.g., nitrate, ammonia, amido-nitrogen, etc. Since the fungus is not digested as in *Dipodium punctatum* and *Psilotum triquetrum* it apparently functions more like an ectotrophic than endotrophic mycorrhiza supplying the host-plant with some of its food material in an organic form and the remainder in the inorganic (mineral substances, water, etc.) from which it manufactures the starch which occurs in considerable quantity in the cells of the ground tissue. From the bacterial activity it seems probable that the host derives most of its nitrogen in an organic form. The nutrition of this orchid, therefore, resembles that of the deeply seated, colourless cells of a higher plant and is heterotrophic entirely.

I am not certain whether the dependence of the orchid upon the mycorrhizic fungus and the bacteria is obligatory, but I am inclined from this investigation, to think that such is the case. However, in a subsequent communication, I intend to submit the results of an investigation into the degree of dependence of saprophytic or semi-saprophytic Angiosperms upon the organisms associated with them.

SUMMARY

1. *Gastrodia sesamoides* is a leafless, non-chlorophyll bearing orchid, which has been erroneously referred to as a possible parasite upon the roots of other plants.
2. It is not parasitic, but is a saprophyte living in association with a mycorrhizic fungus and a bacterium.
3. The fungus inhabits the more superficial cells of the fleshy succulent rhizome, and hyphae penetrate outwards into the soil, establishing communication for a supply of the soil-constituents to the endophytic hyphae and to the orchid.

- 4 There are few roots developed, and no root hairs. A few hairs occur upon the rhizome, which is characterised by numerous annulations bearing colourless scaly leaves. From the apex of this rhizome the flowering-axis is developed. The rhizome is perennial and contains large quantities of starch which stain reddish-brown or pink with iodine.
- 5 The fungal hyphae are not digested by the host-cells and therefore function more like an ectotrophic than an endotrophic mycorrhiza. The fungus produces numerous small thick-walled spores in some of the host-cells.
- 6 Bacteria occur in enormous numbers in the living cells of the rhizomes, in some cases, they are massed in threads passing from cell to cell, in others as ovoid colonies or masses surrounded by a gelatinous matrix. Frequently they occur massed in the vicinity of the nucleus, or distributed densely throughout the cell. They enter the rhizome through the epidermal hairs or through the epidermis itself, and occur in the root and flowering shoot.
- 7 The bacteria can fix the free atmospheric nitrogen, in a culture solution, as much as 7.8 mg of N was assimilated in 15 days, i.e., fully 0.5 mg per day per flask.
- 8 *Gastrodia* is an elaborate example of symbiosis in which an Angiosperm is associated with a Fungus and a Bacterium, and is directly or indirectly dependent upon its endophytes for its carbonaceous and nitrogenous foods.

Botany School, Sydney, April 25, 1923

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A NEW CONIFER FROM SOUTHERN QUEENSLAND

By C. T. WHITE, F.L.S., Government Botanist of Queensland

(Plate xxxvii)

[Read 26th September, 1923]

CALITRIS BAILEYI, n. sp.

Arbor usque 15 m. alta, cortice atro-griseo. *Ramuli* virides, internodis brevibus. *Folia* 3-verticillata, decurrentia prominente carinata. *Strobili* masculi ignoti. *Strobili* feminei solitarii, terminales, oblongi, valvae a dorso prominente calcaratae. *Strobili* maturi subglobosi 1-1.3 cm. diam., columna 3-angulata, 3-4 mm. longa. (Valvae iere aequans.)

A rather slender tree attaining a height of about 50 ft., with a hard, dark grey, compact, not deeply furrowed bark. Branchlets green, internodes short, about 1 line (2 mm.) long on the ultimate branchlets. Juvenile or primordial leaves (on young trees only) acicular pungent-pointed, 4 lines (9 mm. long). Adult or secondary leaves decurrent for the greater part of their length, prominently keeled on the back, free end rather obtuse or bluntly pointed. Male amenta not seen. Female amenta usually terminating short branchlets, oblong, solitary, 6-valved, each valve with a very prominent dorsal spur. Fruiting cones subglobose, 5-6 lines (1.1-1.3 cm.) in diameter, valves slightly wrinkled (usually with a deep central furrow when fully opened), dorsal point prominent but small, central columella stout, 3-angled, $1\frac{1}{2}$ -2 lines (3-4 mm.) long, nearly as high as the valves.

Habitat—Benarkin (type), Rosewood, Nutgrove near Cooyar, Parish of Haly, Kingaroy district, near Wondai, Kingaroy district. The specimens from Kingaroy district are rather imperfect and should be backed by further material.

Distribution—Endemic in South-eastern Queensland.

The species is dedicated to the late Frederick Manson Bailey, the first to collect specimens of this tree, whose name is so closely associated with the flora of Queensland and its elucidation.

The tree evidently has a fairly wide range in South-eastern Queensland, but from reports to hand does not seem abundant in any one locality. The country in which it grows supports a mixture of open Eucalyptus forest and rather thin rain forest or "scrub" characteristic of many parts of South-eastern Queensland with a rainfall of about 35 ins.

In 1917 I sent several specimens of this tree to Mr R. T. Baker, late Curator of the Technological Museum, Sydney, and well known for his work on the Aus-

trahan Conifers. He replied "I have compared your specimens very carefully with the material here studying all the points of similarity and differences of cognate species. The leaves are certainly like some distinct forms of *C. calcarata* being very angular and are too coarse for *C. arenosa* or *C. intratropica*. The fruits are however not typical of *C. calcarata* being so small and the column tall, but I have a few fruits under this species that approach it in size and somewhat in shape, the central column is not that of *C. calcarata* which is nearly always short and divided. I have tried to make it a new species but there are not sufficient differences that I can make out at present from described species."

The tree has been represented in the herbarium collections at Brisbane for a long time. The late F. M. Bailey first gathered it at Rosewood over forty years ago and placed it provisionally as a form of *C. calcarata*. In 1916 I received specimens from Nutgrove (through the Director of Forests) and in 1917 from other localities from different Forest Officers but the specimens were rather poor. In May, 1921, Mr. W. D. Francis accompanied Mr. E. H. Wilson, of the Arnold Arboretum, to Benarkin and they and the Deputy Forester in Charge of the local Forest Office (Mr. F. H. Weatherhead) gathered a good series of specimens on which I have decided to name the tree as a new species. It comes nearest to *C. calcarata* R. Br., but the species can be easily distinguished by the following characters —

Cones 5-6 lines (1.1-1.3 cm) diam., valves often with a deep central furrow when fully open, columella short, 3-angled, 3-4 mm long (nearly as high as the valves) *C. Baileyi*

Cones 7-9 lines (1.5-2 cm) diam., valves thick, never with a central furrow, columella distinctly 3-lobed, short *C. calcarata*

EXPLANATION OF PLATE XXXVII

Callitris Baileyi, n. sp.

- A Shoot from seedling tree showing primordial leaves
- B Fruiting branchlet from adult tree
- C Cone viewed from above
- D Cone, side view
- E Cone with all except two of the valves removed to show the columella.

A REVISION OF THE AUSTRALIAN ANERASTRIANAE (LEPIDOPTERA).

By A. JEFFERIS TURNER, M.D., F.E.S.

[Read 26th September, 1923.]

Superfamily PYRALOIDEA

Family PHYCITIDAE

Subfamily ANERASTRIANAE

This is a natural group although distinguished only by the absence or obsolescence of the proboscis from the rest of the *Phycitidae*. I have some doubt whether it is justly regarded as a subfamily. It is a difficult group. The species are extremely similar, the range of difference between them being small, and at the same time some of the species are much more variable than I had supposed, when the material at my disposal was smaller. Some of the structural characters are variable also. In the attempt to name some Australian species of the group collected by Mjöberg and sent to me from Stockholm I felt the difficulties so much that I have undertaken a revision of all the Australian species. In this undertaking I have made full use of Hampson's revision of the group under the name *Hypsotrophinae* in the Proceedings of the Zoological Society for 1918. This has certainly been of very great assistance, but unfortunately I have found myself unable to follow it on some points. The absence or stalking of vein 5 in both wings gives good generic characters. The separation or stalking of vein 10 in the forewings may be constant in some species, but is variable in so many as to be worthless in distinguishing genera. I have paid special attention to this point, and my results are given in each case. The close approximation of vein 7 of the hindwings to 12 may or may not be accompanied by anastomosis within the limits of one species. The presence or absence of a slight conical projection of the frons, a point often difficult of observation on account of the presence of an anterior tuft of scales, varies in closely allied species. I cannot see that it is more marked in *nummella* and *eurysticha*, referred by Hampson to *Chortonoeca*, than in other species referred to *Anerastia*. The case of *metallactus* is different. Here indeed the conical projection is unusually well marked, but the species seems very near *exasma*, which has also a conical projection, though less marked. I view the difference as one of specific value only, and do not adopt the genus *Metacrateria*. As constituted by Hampson that genus contains four species, one from Australia, one from Ceylon, one from South Africa, and one from Mexico, a geographical distribution which does not suggest that the genus is a natural one. I see no reason to doubt the validity of *Statina* and *Calamotropa*, though I

have seen no examples of them, but I think *Fossifrontia*, which also I have not seen, must be merged in *Saluria*

This revision makes no claim to completeness, but I hope it may mark a substantial advance in our knowledge of the subfamily. I have unfortunately not been able to consult the Romanoff Memoirs, some species I have not seen, and in others my material is still scanty, or confined to one sex. I recognise only five Australian genera which may be easily tabulated

Table of genera

1	Hindwings with 3 and 4 absent	2
	Hindwings with 3 and 4 not both absent	3
2	Forewings with 4 absent, 3 and 5 stalked	<i>Statina</i> .
	Forewings with 4 absent, 3 and 5 separate	<i>Calamotropa</i> .
3	Hindwings with 4 absent	4.
	Hindwings with 4 present	<i>Emmulocera</i> .
4	Forewings with 4 absent	<i>Anerastia</i>
	Forewings with 4 and 5 stalked	<i>Saluria</i>

The ♂ sex shows great variations in the antennae and palpi which are of the greatest value in determining species. By them the genera may be divided into sections which are very convenient and for the most part natural. I have stated the length of the palpi in terms of the breadth of the eye. Although they are often shorter in the ♂, the difference is not always so great as might appear from the measurements given, as the eyes are often smaller in the ♀. A † is prefixed to genera and species which I have not seen.

† Gen STATINA

Rag. N Amer Phyc. p 19, Hmps, Proc Zool Soc, 1918, p 59

Forewings with 4 absent, 3 and 5 strongly stalked. Hindwings with 3 and 4 absent. Type, *S. roseotinctella* Rag from North America

† STATINA RHODOBAPHIELLA

Rag, Nouv Gen, p 50 (1888), Rom Mem viii, p 417, Pl 45, f 6

North Queensland, New Guinea, and Celebes

† Gen CALAMOTROPA

Hmps, Proc Zool Soc, 1918, p 91

Forewings with 4 absent, 3 and 5 separate. Hindwings with 3 and 4 absent. Type, *C. pulverivena* Hmps

† CALAMOTROPA PULVERIVENA

Hmps, Proc Zool Soc, 1918, p 91

Northwest Austr. Sherlock River

Gen ANERASTRIA.

Hb, Verz, p 467

Forewings with 4 absent, 10 separate or stalked. Hindwings with 4 absent, 3 and 5 stalked. Type, *A. lotella* Hb from Europe

In his revision Hampson makes *dignella* Hb the type of *Anerastia*, but many years previously, in his Moths of India, he had named *lotella* as the type, and the name has been used in this sense by other authors for many years before that. If Hampson's restriction of the genus to which *lotella* belongs were ac-

cepted, I should have to adopt *Hypsotropha* Zel. The genus is a large one with considerable range of structural variation. The secondary characters of the ♂ are most valuable as a guide to the species, and in the absence of this sex a species is imperfectly known.

Section 1 Palpi of ♂ ascending and appressed to frons. Antennae of ♂ with dorsal groove and scent-gland towards base.

- | | | |
|---|---|--------------------|
| 1 | Forewings fuscous or rosy-fuscous, veins not outlined | 2 |
| | Forewings rosy, veins outlined with whitish | <i>microrrhoda</i> |
| 2 | Forewings with white costal streak | 3 |
| | Forewings without white costal streak | 4. |
| 3 | Forewings narrow, apex sharply pointed, termen strongly oblique | <i>niphopleura</i> |
| | Forewings moderate, apex round pointed, termen moderately oblique | <i>apotomella</i> |
| 4 | Forewings uniformly fuscous | <i>holophaea</i> |
| | Forewings with fuscous costal streak only | <i>sophopleura</i> |

ANERASTRIA NIPHOPLEURA

Hypsotropha niphopleura, Turn., Proc. Roy. Soc. Qld., 1912, p. 111.

♂ with labial palpi $1\frac{1}{2}$, terminal joint minute, ♀ with labial palpi 5, terminal joint one-third. Maxillary palpi brush-like. Forewings with 10 stalked. This is a much smaller species than the following.

Northern Terr. Darwin, Melville Island.

ANERASTRIA APOTOMELLA

Pempelia apotomella, Meyr., Proc. Linn. Soc. N.S.W., 1879, p. 224 — ♂
Ampycophora haploschema, Turn., Proc. Roy. Soc. Qld., 1903, p. 117 — ♀
Anerastia pleurochorda, Turn., *ibid.*, 1912, p. 117 — ? *Rhinaphe approximella*, Hmps., Proc. Zool. Soc., 1918, p. 82.

♂ with labial palpi $1\frac{1}{2}$, terminal joint minute, ♀ with labial palpi 6, terminal joint one-fifth. Forewings with vein 10 separate or connate.

Qland. Duaringa, Brisbane, Stanthorpe. Also from the Archipelago, Ceylon, and India.

ANERASTRIA HOLOPHAEA

Ampycophora holophaea, Turn., Proc. Roy. Soc. Qld., 1904, p. 42.

Labial palpi curved upwards in both sexes, in ♂ $1\frac{1}{2}$, terminal joint minute, in ♀ $2\frac{1}{2}$, terminal joint $\frac{1}{2}$. Forewings with 10 separate or connate. This and *minimella* are the only species I know in which the ♀ palpi are recurved, in all others they are porrect and curved slightly downwards towards apex.

Northern Terr. Darwin, Queensland. Brisbane.

ANERASTRIA SOPHOPLEURA

Hypsotropha sophopleura, Turn., Proc. Roy. Soc. Qld., 1903, p. 117 —
Anerastia plinthina, Turner, Proc. Roy. Soc. Qld., 1904, p. 43.

♂ with labial palpi $1\frac{1}{2}$, terminal joint minute, ♀ with labial palpi 5, terminal joint $\frac{1}{2}$. Forewings with 10 separate, connate, or stalked.

Northern Terr.: Darwin, North Queensland: Claudie River, Townsville, Queensland. Brisbane.

ANERASTRIA MICRORRHODA, n. sp.

μικρορόδα, small rosy

♂ ♀. 15-22 mm. Head rosy-ochreous; frons flat with short anterior tuft of scales. Palpi pale rosy; in ♂ obliquely ascending, $3\frac{1}{2}$, terminal joint one-sixth, in ♀ porrect, 6-7, terminal joint $\frac{1}{2}$. Antennae rosy-ochreous, in ♂ thickened, dentate, shortly ciliated, with broad dorsal sub-basal groove containing a large tuft of fuscous-tinged scent-hairs; in ♀ simple. Thorax rosy. Abdomen whitish.

grey; base of dorsum ochreous. Legs rosy-ochreous. Forewings rather narrow, costa gently arched, apex rounded, termen obliquely rounded, 10 stalked, rosy; veins narrowly outlined in ochreous-whitish; cilia rosy. Hindwings 2, whitish; cilia whitish.

Except for the structural characters of the male this is scarcely to be distinguished from *chlorogramma* Meyr. The ♀ differs from that species only in the slightly longer palpi. The ♂ palpi are not abbreviated as in the four preceding species.

Northern Terr. Darwin from October to February, 3 ♂ and 10 ♀ examples received from Mr F. P. Dodd.

Section 2. Palpi of ♂ ascending and appressed to frons. Antennae of ♂ without dorsal gland.

ANERAETRIA MINIMELLA

Mahurpha minimella, Hmps., Rom. Mem. viii, 1901, p. 392, Pl. 52, f. 11.

Palpi ascending in both sexes with short terminal joint, in ♂ 2½, in ♀ 3½. Antennae of ♂ with subdorsal groove but no visible gland, serrate, shortly ciliated. Forewings with 10 separate.

Northern Terr. Darwin; North Queensland. Thursday Island. Also from Celebes and Borneo.

Section 3. Palpi of ♂ porrect, or at most slightly ascending, at apex usually depressed. Antennae of ♂ with dorsal groove and scent gland towards base.

- | | |
|---|-----------------------|
| 1. Forewings with white costal streak | 2. |
| Forewings without white costal streak | 5. |
| 2. Forewings without well-defined subcostal streak | <i>niphosema</i> |
| Forewings with fuscous subcostal streak | 3. |
| 3. Forewings narrow, apex pointed, termen strongly oblique | <i>icasmopsis</i> |
| Forewings moderately broad, apex round-pointed, termen moderately oblique | 4. |
| 4. Forewings with dorsum suffusedly whitish | <i>stereosticha</i> . |
| Forewings with dorsum pale-fuscous | <i>eurysticha</i> . |
| 5. Forewings rosy or greyish, veins outlined with whitish | <i>virginella</i> . |
| Forewings not so | 6. |
| 6. Forewings streaked with brown and spotted with fuscous | <i>dysommata</i> . |
| Forewings without markings | <i>maroida</i> . |

ANERAETRIA NIPHOSEMA.

Hypsotropa niphosema, Turn, Proc. Roy. Soc. Qld., 1912, p. 112.

Palpi of ♂ 6, of ♀ 8. Antennae of ♂ thickened, serrate towards base, shortly ciliated. Forewing with 10 connate or stalked.

Northern Terr. Darwin.

ANERAETRIA ICASMOFIS.

Hypsotropa icasmopsis, Turn, Proc. Roy. Soc. Qld., 1903, p. 116.

Palpi of ♂ 6. Forewings with 10 stalked.

North Queensland. Townsville.

ANERAETRIA STEREOSTICHA.

Hypsotropa stereosticha, Turn, Proc. Roy. Soc. Qld., 1904, p. 41.

Palpi of ♂ 5, of ♀ 7. Forewings with 10 stalked. This species should not be difficult to recognise. The fuscous irroration sometimes forms fine longitudinal streaks. Besides the imperfect type, I have a ♂ from the same locality.

North Queensland. Thursday Island.

ANERASTRIA EUREYSTICHA.

Turn., Proc. Roy. Soc. Qld., 1903, p. 119.

Palpi of ♂ 5 Forewings with 10 separate or stalked. This should not be confused with *niphosema*

North Queensland: Townsville; two examples.

ANERASTRIA VIRGINELLA.

Meyr., Proc. Linn. Soc. N.S.W., 1880, p. 233—*Erythphlebia enervella*, Hmps., Rom. Mem. viii., p. 394, Pl. 39, f. 24—*Hypotropha newica*, Turn., Proc. Roy. Soc. Qld., 1912, p. 113—*Anerastia ablepta*, Turn., *ibid*, p. 114.

Palpi of ♂ 5, of ♀ 8. Antennae of ♂ dentate, shortly ciliated. Forewings with 10 separate or stalked. Varies in colour from deep rosy through rosy-grey to grey, in expanse from 18 to 32 mm, in neurulation, and in degree of development of white streaks on forewings.

Northern Terr.: Darwin, North Queensland: Claudie River, Cooktown, Cairns, Townsville; Queensland. Peak Downs, Duaringa, Nambour, Brisbane, Stradbroke Island, Mt. Tambourine, Toowoomba, Bunya Mts; N.S. Wales: Lismore, N.W. Aust. Sherlock River, Kimberley. Also from New Guinea

ANERASTRIA DYSEIMATA.

Hypotropha dyseimata, Turn., Proc. Roy. Soc. Qld., 1912, p. 113—*Anerastia acrophaea*, Turn., *ibid*, p. 117

Palpi of ♂ 5, of ♀ 7. Antennae of ♂ dentate, shortly ciliated. Forewings with 10 separate or stalked

Northern Terr.: Darwin. Also recorded by Hampson from Timor Lant

ANERASTRIA MAROIDA, n. sp.

maroides, faded.

♂ ♀. 20 mm. Head and palpi ochreous-whitish, in ♂ fuscous-tinged; palpi porrect, in ♂ 2, in ♀ 3. Antennae ochreous-whitish; in ♂ shortly ciliated, with a broad dorsal sub-basal groove containing a large tuft of fuscous scent-hairs. Thorax ochreous-whitish. Abdomen ochreous-whitish, base of dorsum ochreous. Legs fuscous, paler in ♀. Forewings moderate, costa slightly arched, apex round-pointed, termen slightly oblique; 10 separate, whitish-ochreous, sparsely irrorated with pale-fuscous; cilia whitish-ochreous. Hindwings and cilia whitish

Queensland: Miles, in November and December; two specimens.

Section 4. Palpi of ♂ porrect. Antennae of ♂ without dorsal gland, bipectinate.

ANERASTRIA BISERIKILLA

Hmps., Rom. Mem. viii., 1901, p. 397, Pl. 52, f. 18.

♂ ♀. 18-22 mm. Head and palpi fuscous; palpi porrect in both sexes, in ♂ 5, in ♀ 5. Antennae fuscous; pectinations in ♂ 8. Thorax pale-fuscous. Abdomen ochreous-whitish, base of dorsum ochreous. Legs whitish; anterior pair fuscous. Forewings moderate, costa gently arched, apex round-pointed, termen obliquely rounded; 10 separate; fuscous, becoming whitish towards dorsum; a subterminal line of fuscous dots, sometimes indistinct; a whitish costal streak, narrow at base, broader towards middle, narrowing to a point just before apex; costal edge fuscous towards base; cilia fuscous-whitish. Hindwings whitish, tinged with grey towards apex and termen; cilia whitish. I have not seen Hampson's description, but my specimens agree in structure. His type is from Queensland

Northern Terr Darwin (Dodd), North Queensland Cooktown, Northwest Austr Kimberley (Mjöberg), Sherlock River

Section 5 Palpi of ♂ porrect Antennae of ♂ without sub-basal gland, not pectinate

1	Frons with long conical truncate horny process	<i>metallactis</i>
	Frons slightly or not projecting though with anterior tuft	2.
2	Forewings with white costal streak	3
	Forewings without costal streak	4.
3	Head pale-fuscous	<i>syssema</i>
	Head white	<i>macrorrhyncha</i>
4	Forewings with fuscous dots and lines	<i>acidnias</i>
	Forewings without fuscous markings	5
5	Forewings rosy palpi 3 to 5	<i>chlorogramma</i> .
	Forewings ochreous-grey, palpi 7	<i>psamathella</i>

ANERASTRIA METALLACTIS

Meyr, Trans Ent Soc, 1887, p 262

Frons conical and very strongly projecting with truncate apex Palpi of ♀
6 Forewings with 10 separate or stalked I have four ♀ examples, but for the ♂ characters have had to rely on Meyrick and Hampson

Northern Terr Darwin, N S Wales Bathurst.

ANERASTRIA SYSSFMA

Turn, Proc Roy Soc Qld, 1912, p 113

Palpi in ♀ 6 Forewings with 10 separate, connate, or stalked I have seen no ♂ of this species, but rely on Hampson for the antennal characters The fine longitudinal streaks of fuscous irroration parallel to veins distinguish it from all except *metallactis*, from which it differs in the less prominent frons, and clear white costal streak on forewings

Northern Terr Darwin, Northwest Austr Kimberley (Mjöberg) Hampson records it from Queensland

ANERASTRIA MACRORRHYNCA, n sp

μακρορύγχος, long-nosed

♂ 18 mm Head white Palpi in ♂ 7, grey Antennae grey; in ♂ dentate with tufts of cilia (1) Thorax white, patagia grey Abdomen whitish, base of dorsum ochreous Legs fuscous, posterior pair whitish Forewings rather narrow, dilated posteriorly, costa straight to near apex, apex pointed, termen scarcely rounded, oblique, 10 separate, grey, towards dorsum suffusedly whitish with grey irroration, a white costal streak from base to near apex, on costal edge irrorated with grey, cilia grey Hindwings 2½, grey-whitish, terminal edge grey, cilia white

North Queensland Townsville in April, one specimen received from Mr F. P Dodd

ANERASTRIA ACIDNIAS

Hypsotropa acidnias, Turn, Proc Roy Soc Qld, 1903, p. 117

Palpi of ♂ 5 Forewings with 10 stalked

North Queensland Townsville

ANERASTRIA CHLOROGRAMMA

Meyr, Proc Linn Soc N S W., 1889, p. 1116 — *Hypsotropa rhodosticha*, Turn, Proc Roy Soc Qld, 1903, p. 116

Palpi of ♂ 3, of ♀ 5. Antennae of ♂ serrate, shortly ciliated Forewings with 10 stalked in a long series examined

Queensland: Duaringa, Brisbane, Rosewood

ANERASTRIA PSAMATHELLA

Meyr, Proc Linn Soc N S W, 1879, p. 234 — *A. nitens*, Butl, Trans Ent. Soc, 1886, p. 440. — *A. balora*, Turn, Proc Roy Soc Qld, 1912, p. 116

Palpi of ♂ 7, of ♀ 9. Antennae of ♂ shortly ciliated Forewings with 10 separate or stalked My material is scanty, but I think the subdorsal and sub-terminal fuscous dots sometimes present are merely varietal

North Queensland Cairns, Queensland Peak Downs, Brisbane, Dalby; N S Wales Sydney, Vict Fernshaw

Unclassified Species

ANERASTRIA LAROPIS

Hypotropha laropis, Turn, Proc Roy Soc Qld, 1912, p. 113.

Unfortunately the type has been destroyed by an *Anthrenum*, so that only one forewing remains Further material is required to establish its distinctness

Northern Terr. Darwin

ANERASTRIA ERASMIA

Turn, Proc Roy. Soc Qld, 1912, p. 117

Palpi of ♀ 7 Forewings with 10 separate ♂ unknown I think this is a good species

North Queensland. Herberton

ANERASTRIA ARGOSTICHA

Turn, Proc Roy Soc Qld, 1912, p. 115

Palpi of ♀ 4 Forewings with 10 separate ♂ unknown Like *virginella*, but with shorter palpi and costa of forewing less strongly arched

Northern Terr Darwin

ANERASTRIA ANAEMOPTIS

Turn, Proc Roy Soc Qld, 1912, p. 116

Palpi of ♀ 6 Forewings with 10 stalked Very like *psamathella*, but with shorter palpi and apex of forewing less acute The ♂ is required for certainty

Northern Terr. Darwin

† ANERASTRIA MINORALIS

Low, Trans Roy Soc S Aust, 1903, p. 52 North Queensland

† ANERASTRIA XIPHIMELA

Low, Trans. Roy Soc S Aust, 1903, p. 52 North Queensland

† ANERASTRIA TALIELLA

Hmps, Rom Mem viii, 1901, p. 402, Pl. 53, f. 17 Queensland

† ANERASTRIA EURYZONA.

Hypotropha euryzona, Meyr, Ent Mo Mag, 1882, p. 256, Rag, Rom Mem viii, p. 382, Pl 39, f. 13.

Unfortunately I have been unable to consult either of these authorities South Austr.: Wirrabara.

A REVISION OF THE AUSTRALIAN ANTHRASTIDAE,

Gen. SALURIA.

Rag, Ann. Soc Ent Fr., 1887, p. 258.

Forewings with 4 and 5 stalked, 10 separate or stalked. Hindwings with 4 absent, 3 and 5 stalked Type, *S. maculevistella* Rag. from the Mediterranean region

Section 1 Palpi in ♂ ascending, appressed to frons, abbreviated. Antennae of ♂ unipectinate, with large sub-basal, dorsal groove and gland.

SALURIA ADENOCERA, n.sp.

ἀδνοκέρως, with glandular antennae

♂ 22 mm Head pale-fusces Palpi in ♂ short (1½), curved upwards and appressed to frons, pale-fusces Antennae pale-fusces, pectinations in ♂ 1. Thorax pale-fusces Abdomen whitish-ochreous Legs pale-fusces, posterior pair ochreous-whitish Forewings moderate, costa gently arched, apex rounded. termen obliquely rounded, 10 stalked, pinkish-grey; veins obscurely whitish, cilia grey-whitish Hindwings 2, grey-whitish, cilia whitish

North Queensland Kuranda near Cairns in December; one specimen received from Mr F P Dodd

† SALURIA LEUCONEURELLA

Fossifrontia leuconeurella, Hmps, Rom Mem viii., p 339.

I do not know this species, but from Hampson's description place it here. The antennae are said to be uniserrate, which may be taken as shortly unipectinate, the frons has a truncate conical prominence, and the ♂ has a small median costal fold with a small patch of androconia on underside of forewing In other structural characters it corresponds with the preceding species.

North Queensland. Cooktown.

Section 2. Palpi of ♂ short, ascending. Antennae of ♂ with sub-basal dorsal gland, not pectinate

SALURIA RHODOESSA.

Turn, Proc Roy. Soc Qld., 1903, p 120.—? *S. distinctella*, Hmps, Proc Zool. Soc, 1918, p 101.

Palpi of ♂ ascending, 1½, of ♀ porrect, 5. Antennae of ♂ thickened, very shortly ciliated Forewings with 10 separate, connate, or stalked; 4 and 5 short-stalked, sometimes nearly connate Hindwings with 3 and 5 short-stalked (1 ♂, 1 ♀), or very closely approximated for some distance (2 ♀ certainly of the same species), 7 anastomosing or closely applied to 12. *S. distinctella* Hmps. may be a synonym, but if so I doubt the Brisbane locality

North Queensland Cairns, Townsville.

Section 3 Palpi of ♂ porrect Antennae of ♂ without sub-basal dorsal gland, unipectinate

- | | | |
|---|---|----------------------|
| 1 | Antennal pectinations of ♂ over 2 | 2. |
| | Antennal pectinations of ♂ less than 1 | <i>holochra.</i> |
| 2 | Antennal pectinations not extending to middle | <i>pleurosticha.</i> |
| | Antennal pectinations extending beyond two-thirds | <i>stenucha.</i> |

SALURIA PLEUROSTICHA.

Hypotropha pleurosticha, Turn., Proc Roy. Soc. Qld., 1903, p. 115.

Palpi of ♂ 4 Antennae of ♂ with long pectinations (3) not extending to middle, remainder of antennae ciliated. Forewings with 10 stalked.

North Queensland Townsville

SALURIA OTENUOLA.

Poujadia otenuola, Turn., Proc. Roy. Soc. Qld., 1912, p. 118.

Palpi in ♂ 3½ to 4; in ♀ 7. Antennae of ♂ with long pectinations (3) extending nearly to apex. Forewings with 10 separate, connate, or stalked, most commonly the last. A variable species. The whitish costal streak, rarely very distinct, may be absent in both sexes. A postmedian, a sub-dorsal, a series of sub-terminal, and another of terminal dots may be present, but are all inconstant.

Northern Terr.: Darwin, North Queensland. Townsville

SALURIA HOLOCHRA.

Poujadia holochra, Turn., Proc. Roy. Soc. Qld., 1903, p. 121.

Palpi of ♂ 6. Antennae of ♂ with pectinations very short (½), ending in tufts of short cilia, and extending to apex. Forewings with 10 separate

Viet. Birchup

Unclassified Species

SALURIA CALLIRRHODA

Poujadia callirrhoda, Turn., Proc. Roy. Soc. Qld., 1903, p. 120

Palpi of ♀ 6. Forewings with 10 connate. ♂ unknown. Apparently distinct but further discoveries may unite it with *rhodoessa*. I know only the type, but have seen a second example.

North Queensland: Townsville, Claudie River

SALURIA LEUCONEURA

Poujadia leuconeura, Turn., Proc. Roy. Soc. Qld., 1912, p. 118.

Palpi of ♀ 3½. Forewings with 10 separate. Hindwings with 7 closely applied to 8, but not anastomosing. ♂ unknown.

Northern Terr.: Darwin

SALURIA GRAMMIVENA

Hmps., Proc. Zool. Soc., 1918, p. 99

Palpi of ♀ 7. Forewings with 10 separate. I have not seen a ♂, but according to Hampson the antennae of that sex are not pectinate, but have the sub-dorsal groove and gland.

Northern Terr.: Alexandria; Northwest Austr.: Sherlock River.

SALURIA DESERTELLA.

Hmps., Proc. Zool. Soc., 1918, p. 97

Palpi of ♀ 7. Forewings with 10 separate. Hindwings with 7 closely applied to 8, not anastomosing. ♂ unknown.

Northern Terr.: Alexandria, Queensland. Charleville; Northwest Austr.: Sherlock River.

† SALURIA NEURICELLA.

Hmps., Proc. Zool. Soc., 1918, p. 98.

Queensland. Peak Downs.

† SALURIA NEOTOMELLA.

Eucarpia neotomella, Meyr., Proc. Linn. Soc. N.S.W., 1879, p. 226; Rag., Rom. Mem., p. 368, Pl. 7, f. 25. New South Wales.

† SALURIA ENSIFERELLA.

Eucarpia ensiferella, Meyr., Proc. Linn. Soc. N.S.W., 1878, p. 208; Rom. Mem., viii., p. 366, Pl. 39, f. 2. New South Wales.

I have two ♀ examples of an undescribed species which I refer here, though it resembles *Emmalocera* in vein 4 of hindwings separating from 5 before margin; 4 and 5 of forewings are strongly stalked

Gen EMMALOCERA

Rag, Nouv Gen, 1888, p 38

Forewings with 4 and 5 closely approximated at origin and for a short distance, rarely connate or short-stalked, 10 separate or stalked. Hindwings with 3 from lower angle of cell closely approximated or connate with 4, 5, which are stalked, 7 closely applied to 12, sometimes anastomosing. Type, *E leucocincta* Wlk from the Archipelago

Differs from *Saluria* in the presence of 5 in the hindwings, and the separation of 4 and 5 in the forewings. Neither distinction is absolute; rarely in *Saluria* vein 5 of hindwings separates near margin, rarely in *Emmalocera* veins 4 and 5 of forewings are short-stalked, but taken together the differences are probably sufficient

Section 1 Palpi of ♂ ascending. Antennae of ♂ unipectinate with sub-basal dorsal groove and gland

Antennal pectinations of ♂ 3

longiramella

Antennal pectinations of ♂ 1 or rather less

latilimbella.

EMMALOCERA LONGIRAMELLA

Hmps, Rom Mem viii, p 315, Pl 52, f 16

Palpi of ♂ ascending, 3½, of ♀ porrect, 6. Antennae of ♂ with long pectinations (3) extending nearly to apex. Forewings with 10 separate, 4 and 5 approximate at origin, connate, or very shortly stalked, greyish-pink, with whitish costal streak. The absence of a fuscous subcostal streak will usually distinguish it from *latilimbella*, but not always, and I know no way of certainly distinguishing the ♀

Northern Terr. Darwin (2 ♀), North Queensland. Townsville, Queensland. Brisbane

EMMALOCERA LATILIMBELLA

Papua latilimbella, Rag, Bull Ent Soc Fr, 1889, p 220, Rom. Mem viii, p 313, Pl 36, f 7 — *Polyocha rhabdota*, Turn, Proc Roy. Soc Qld, 1903, p 122 — *P achrosta*, Turn, ibid., p 122 — ? *Emmalocera radiatella*, Hmps., Rom Mem viii, 1901, p 315, Pl 52, f 21

Palpi of ♂ 2½, ascending, of ♀ 6, porrect. Antennae of ♂ shortly unipectinate (two-thirds to 1) with tufts of short cilia. Forewings with 10 separate, connate, or stalked, 4 and 5 approximated, connate, or very shortly stalked. Hindwings with 7 closely approximated to 12, rarely anastomosing

A common species, of which I have a large series. It varies much in colouring of forewings, from a pink as defined as in *longiramella* through various shades of pinkish-grey to whitish-grey, usually there is a fuscous subcostal longitudinal streak, sometimes strongly pronounced, but sometimes absent. Hampson was right in placing *rhabdota* and *achrosta* here and, though I have not seen the description of *radiatella*, I strongly suspect it is the same. The length of the antennal pectinations varies a little, and in some the antennae might be almost equally well described as serrate

North Queensland. Cairns, Atherton, Herberton, Queensland. Brisbane, Stradbroke Island, Coolangatta, Bunya Mts., Dalby, Stanthorpe; N S Wales: Tabulam, Ben Lomond (3,500 ft). Also from New Guinea.

Unclassified Species

EMMALOCERA ACHROMATELLA.

Polyocha achromatella, Hmps., Proc Zool Soc, 1918, p 126 —? *Emmalocera eremochroa*, Hmps, *ibid*, p 130

Palpi of ♀ 8. Forewings with 10 separate, 4 and 5 very closely approximated for a short distance Hindwings with 4 and 5 shortly stalked, 7 anastomosing with 12 ♂ unknown

These particulars are taken from a single example In Hampson's first type 4 and 5 of forewings appear to have been short-stalked

Queensland Dalby, N S Wales Broken Hill, ? Northwest Austr Sherlock River

ON SOME ABNORMAL SUGAR-CANES

By THOS. STEEL.

(Plate xxxviii)

[Read 26th September, 1923]

During a period of many years' service with the Colonial Sugar Refining Co., Ltd., of Sydney, I took every opportunity which offered of securing specimens of abnormal sugar-canes. Through the kindness of several colleagues in the service, notably Messrs M. P. Brownrigg, M. S. Barnett, the late James Clark and the late W. A. Speight, I was able to secure a number of somewhat interesting teratological specimens of which I have had drawings prepared. The specimens themselves are preserved in formalin and deposited in the Museum of the Botanic Gardens, Sydney.

Most of the specimens are products of seedling canes, which have proved more prolific in this direction than those grown in the usual manner from pieces of the cane-stalks termed "sets."

Plate xxxviii, fig. 1, shows forking, a rare occurrence in a monocotyledon. This was from a seedling Salangore cane and, though not a characteristic of this particular variety, was of occasional occurrence. The same peculiarity is seen in figs. 3 and 4, seedlings from the variety known as striped Singapore, and, like fig. 1, raised at Hambleton plantation, Queensland, by Mr. Clark. Besides forking, these show several sets of double and one of triple budding. The forking was considered by Mr. Clark to be due to the multiple budding. About 5 per cent of the stalks showed forking and multiple budding, many others died off in the effort, thus seriously affecting the yield; the quality also was poor. When used as sets for planting, the peculiarity was reproduced in about the same ratio. The buds in sugar-cane are normally placed alternately on the stalks and these specimens follow this rule. It will be noticed that one of the pairs in fig. 4 has the buds separated by a notable distance, and this is also apparent at the forking point in both figures.

Fig. 2 represents a cane having egg-shaped joints. It was grown at Hambleton, Queensland, from sets and was stated to have been brought from Singapore by Chinese for eating purposes. It was a poor cropper, but very sweet.

Figs. 5 and 10, a seedling from the variety known as Salangore, has a number of buds suppressed. Occasionally whole stalks occurred having no buds. This was a poor cane and was considered to be a degenerate due to inbreeding.

Fig. 6, an example of a variety from Mauritius, named "Hybrid Footingoo," grown from a set, is very subject to multiple budding, triple and quintuple buds being common. The figure shows a five bud example. Sets from the multiples

budded canes when planted usually produce normal plants, with a proportion of multiple budded stalks.

Figs. 7 and 9 grown from sets of a cane brought from Mauritius, and known as "G 3 Kew seedling," show a malformation common in this variety, about one-third of the stalks being so affected. The short malformed joint is usually hollow.

Fig. 8 is an unusual instance in which all the joints are malformed. It bears a distinct resemblance to Fig 2.

Amongst the specimens there is an interesting example grown from a set of Badilla cane, in which there are two opposite buds at every node, the buds at the alternate joints being placed at right angles to one another

The internodes are very short, being only 11 mm. in length. The nodes are of normal length, 11 to 12 mm., while the diameter of the stalk is also normal, about 45 mm. I have no information as to whether part only or the whole stalk was malformed.

An example of a precisely similar malformation in a cane known as Yellow Jamaica is described and figured by F. Zerbán, of the Sugar Experimental Station, Lima, Peru (*Internat Sugar Journ*, xi., 1909, 198). One stalk only was found

In canes of normal growth the length of internode varies as a rule from 100 to 150 mm, but occasionally under favourable conditions longer joints are produced. I have seen canes in the tropics with the internodes 200 to 225 mm. Dry or cold conditions produce short internodes. In two-year-old cane grown in places like New South Wales, where it is subject to frost, the middle part of the stalk or winter growth has always got short joints

Although there is evidence that sugar-cane has been grown from seedlings—probably self sown—in a more or less desultory manner at many different places, over a period of many years, it was for a long time widely held that the plant, through long cultivation from sets, had lost the power of producing fertile seed. Some varieties do not appear to produce fertile pollen, but can themselves be fertilised from other varieties. Much information on these aspects of the subject is given by Noel Deer in his book (*Cane Sugar*, 1921)

Some peculiarities have been noticed in the experimental cultivation of seedling canes in Queensland. The buds are found to vary greatly in shape amongst the different varieties, there being large, small, round, flat, pear-shaped, pointed and prominent buds. Seedling canes are of various colours ranging through many shades of green to red, purple and black, and it has been noted that, though well developed stalks were raised from seeds yielded by striped canes, none of the seedlings was striped, with the exception of an odd stalk of a purple cane which showed faint stripes on its upper half, the lower portion next the ground being of a uniform purple colour. In a dozen stools raised from Striped Singapore, a yellow cane with purple stripes, the canes were all either green or purple, chiefly the latter, but without any trace of stripes. Sets of striped canes when planted produce similar striped canes and it is interesting to find that this character is not reproduced in seedlings.

In considering the elimination of stripes in seedling canes, it must be remembered that most, at any rate, of the numerous varieties in cultivation have arisen from the original stock through selected propagation by sets. Probably the original wild cane was a plain yellow, green, or purple, without stripes, and the stripeless seedlings are simply reversions toward the original. In my examination of Fijian wild cane (*Proc Linn. Soc. N.S. Wales*, xvi., 1921, 488) I found that

two colours of stalks grew mixed together, plain red and plain yellow, without stripes

Much variation in length and thickness of stalk occurs amongst groups of seedling canes. Some may be no thicker than a pencil, whilst others have large massive stalks. Some tend to be recumbent, whilst others grow quite straight

DESCRIPTION OF PLATE XXXVIII

Abnormal Sugar-Canes

Fig 1 Forking of sugar-cane Fig 2 Egg-shaped joints Figs 3 and 4 Forking and multiple budding Figs 5 and 10. Suppressed buds Fig 6 Multiple budding Figs 7, 8 and 9 Malformed joints

(Figures 1—10, x two-sevenths)

THE STROPHOMENIDAE FROM THE FOSSILIFEROUS BEDS OF BOWNING, NEW SOUTH WALES

Part I STROPHEODONTA

By JOHN MITCHELL, late Principal of the Newcastle Technical College and School
of Mines

(Plates xxxix-xlii.)

[Read 31st October, 1923]

Introduction

The history of the Stropheodonta group in Australia is a brief one, for the only forms belonging to it yet recorded from Australian rocks are the species described by Mr Chapman (Proc. Roy Soc Vic, 16 (ns), 1903, 69-73, Pl. xi., figs 5-7 and Pl. xii, figs 1-6) from Lilydale, Vic and considered by him to be of Upper Silurian age (Yeringian). They include the following species -- *Stropheodonta* (*Leptostrophina*) *alata* Chap., *S.* (*Brachyprion*) *lilydalensis* Chap and *Strophonella euglyphoides* Hall.

In the present paper the following species of *Stropheodonta* are described, all except *S. tarloensis* being from the Bowning (*Bounyongian*) Beds which are practically the equivalents of Mr Chapman's Melbournean and Yeringian Beds, and of Barrande's étages E and F of the Upper Silurian of Bohemia -- *bendeninensis*, *silverdalensis*, *borseoides*, *conica*, *phalaenoides*, *transversa*, *lilydalensis* Chapman, *quadrata*, *incerta*, *davidi*, *minuta*, *tarloensis*, *bowningensis*, *striato-costata*, *striato-punctata*, *fragilis* and sp. indet. All are new except *lilydalensis*.

A remarkable thing about the Stropheodontas from the Bowning Beds is that those found in the Lower Trilobite beds and in beds below that horizon possess, almost without exception, spines proceeding from the cardinal angles and, in this particular, differ from foreign members of the group among which the possession of spines proceeding from the cardinal angles is very exceptional. These spines, together with the Leptostrophian character of their hinge plates and teeth, indicate their archaic origin. The forms derived from the upper beds are small, without cardinal processes and have the hinge-plate and teeth strongly developed; except for their small size, they appear to be more closely allied to Devonian than Silurian types. In size and in other respects the Bowning forms of the group differ from foreign types. *S. varistriata* Conrad and *S. perplana* Conrad, from the lower Helderberg, are the only ones among the many North American species which bear striking resemblances to any of the local types. *S. borseoides*,

in size, shape, having a depressed umbonal area, and being strongly inflated ventrally, resembles *S. varistrata*. *S. euglyphoides* Chap. has some features in common with *S. perplana*. A close agreement in the two sets of types cannot be expected considering the great distance which separates them.

One of the most striking things observable in the local forms from the older beds is the absence of defined muscular areas on the brachial valves. Another feature found, almost if not altogether without exception, is the lateral extension of the hinge-plates into long, acicular, straight spines or processes. In a few cases spines of this nature are known to occur on foreign *Stropheodonta* and *Strophonella*, but with species from the older beds at Bowning, the occurrence is the rule and not the exception. This spination of the latero-cardinal angles seems to have belonged, in Australia, to the more ancient forms of the genus, just as appears to have been the case with some *Stropheodontas* of North America as, for example, *Brachypirion leda* Billings. Soon after passing above the Middle Trilobite Beds of the Bonnyvongian series, this type of *Stropheodonta* is no longer met with, but instead, a group of small forms makes its appearance. This group may be divided into two or more types—the smaller and more ancient type, which appears first in the Lower Trilobite Beds of the Bowning formation, is represented by *Stropheodonta minuta*, another by *Stropheodonta davidi* and perhaps still another by *Stropheodonta striato-punctata*.

Besides the species dealt with in the present paper, there are several others, the determination and description of which has been deferred for the present. They have chiefly been collected from the Lower Limestone Beds of Derrengeullen Creek.

It may be stated that I have compared the *Stropheodontas* included in the present paper with those described and figured from the Devonian of the Northern Shan States by F. R. Cowper Reed (*Pal. Indica*, (N. S.), Vol. 2, mem. 5, 1908), and find none of those to be closely related to the Bowning forms. It appears, as is to be expected, that the fauna of the Shan States has closer affinity with the European fauna than with that of Australia.

In conclusion, I wish to thank Professor Sir Edgeworth David for his help in having the specimens photographed for the plates, Mr. W. S. Dun, Palaeontologist to the Geological Survey of N. S. W., for assistance in various ways and Dr. C. Anderson, Director, Australian Museum, for access to literature. Further my cordial thanks are tendered to Mr. H. G. Goode for the photographs illustrating the paper.

STROPHODONTA BENDENINENSIS, n. sp. (Pl. xxxix, figs. 1, 2, Pl. xli, fig. 18)

Pedicle valve subsemicircular to subquadrate, strongly convex about the muscular area, somewhat depressed towards the lateral margin. The test is absent and has left no trace of the radials, but the vascular system is clearly exposed, the whole surface of the valve is densely covered with fine punctures. Hinge-plate fairly wide and evidently produced laterally into spines, but they are not shown on the specimen, muscular scars triangular, prominent and separated medially by a short and shallow septum, umbo moderately prominent and bifid.

Dimensions. Length 12-13 mm., width 17-18 mm., depth (approx.) 3 mm.

The brachial valve is unknown.

One specimen has the test partly preserved, and shows the radials.

In outline this species resembles both *S. striata* Hall and *S. perplana* Conrad, but not in other respects.

Loc and horizon—Yass-Buruwa road near Bendenine public school, Limestone Creek, and Bowning Creek, Parish of Bowning—Lower Trilobite beds of the Bounyongian Beds

STROPHEODONTA SILVERDALENSIS, n sp (Pl xxxix, fig 3)

Pedicle valve (partly testiferous) large, subsemicircular, strongly convex. Radials numerous, not prominent, indistinct towards the cardinal angles. Concentric striae numerous but indistinct. Umbo prominent and depressed dorsally, muscular scars not exposed. Hinge-plate moderately wide, straight, produced into long spines at the cardinal angles. Punctures fine and numerous. Brachial valve not known. *Dimensions* Length 20.3 mm, width 26.5 mm.

This is the largest of the Bowning Stropheodontas, but is only of medium size when compared with some from other countries. In size and in having the hinge-plate produced into spines at the cardinal angles it resembles *Stropheodonta perplana*, as it also does in possessing slightly wrinkled radials.

Loc and horizon—This species was collected from a thin bed of shale interbedded with the lower limestone beds near the junction of Derrengullen and Limestone Creeks, Parish of Derrengullen, County King. Upper Silurian.

STROPHEODONTA BORSEOIDES, n sp (Pl xxxix, figs 5-8, Pl xl fig 9)

Brachial valve attains its greatest concavity medially and between there and the beak slopes gradually, it slopes more steeply towards the ventral margin, subsemicircular, ventral margin mildly rounded, sides almost vertical, radials faint, hardly visible on many (nontestiferous) specimens, simple, numerous, evenly spaced. Muscular scars and umbo invisible. Hinge-plate long, relatively wide, straight and produced into long slender spines at the cardinal angles, teeth small, few in number and borne on a low knife-edged ridge extending medially along the plate on each side of the beak. The valve has a very baggy or purse-like shape. Punctuation invisible. The following is the description of what is assumed to be the pedicle valve. Strongly convex, except adjacent to the cardinal angles where it is depressed. Ribs numerous (about forty), thread-like, not so wide as the interspaces, faint near the cardinal angles. Punctures fine and of even size, not present near the margins. Muscular area triangular and prominent. Hinge-plate straight, produced into spines at the cardinal angles. A very delicate septum present. *Dimensions* 12-16 mm. long, 18-22 mm. wide.

This is the largest Stropheodonta from the Lower Trilobite beds of the Bowning Beds, but it is much smaller than some from the limestone beds of Limestone Creek, and still smaller when compared with such species as *S. demissa* Conr. and *S. concava* Hall from USA. It does not closely resemble any foreign species which has come under my notice nor is it identical with any of those described by Mr. Chapman from Victoria (Proc. Roy. Soc. Viet., 1903, 60-62, Pls. x-xii).

As the valves of the species have not been found conjoined it is not absolutely certain that the valves described above belong to the one species, but they were found in association and agree dimensionally, hence the assumption that they represent the two valves of a single species appears to me a reasonable one.

Loc and horizon—Lower Trilobite beds of the Bounyongian Beds, Bowning Creek, Silverdale and Hatton's Corner, Yass River, associated with *Encrinurus bowningensis*, *E. mitchelli*, *Ceratocephala vogdesi*, *C. jacki*, *C. phalaenocéphala*, *Odontopleura bowningensis*, etc.

STROPHODONTA CONICA, n.sp. (Pl xl, fig 10)

Pedicle valve obverse conical, evenly convex, radials thread-like, numerous, conspicuous on the median part only, and consisting of primaries and secondary interpolations, umbo fairly prominent, muscular area distinct, hinge-plate narrow, straight and produced into spines laterally, teeth small, numerous and apparently occurring along the whole length of the hinge-plate, except under the beak; punctuation quite indistinct. Brachial valve unknown. *Dimensions* Length 9.5, width 11.0, depth (approx.) 3 mm.

The distinctive features of the species are its reversed conical shape, the approximate equality of length and width and its long acicular lateral processes of the hinge-plate.

Loc. and horizon—Minahan's selection, Bowning Creek, one and a half miles NW of Bowning township, Parish of Bowning. Lower Trilobite beds of the Bounyongian Beds.

STROPHODONTA PHALAENOIDES, n.sp. (Pl xl, fig 11)

Pedicle valve convex, depressed near the cardinal angles where also the surface is smooth in nontestiferous specimens. Ribs not prominent, ridged, consisting of about twelve primaries and ten secondary interpolations, interspaces shallow. The whole surface very finely punctate, except near the margins, umbo prominent, muscular area triangular, divided by short and faint septum, and ill-defined. Hinge-plate narrow, straight, produced into long acicular spines at the cardinal angles, teeth few and very small. Brachial valve plain or very slightly convex, ribs indistinct, of irregular outline, in number apparently equal to those of the pedicle valve, concentric lines faintly visible. Hinge-plate, teeth and spines of the cardinal angles similar to those of the other valve, umbo and muscular area quite inconspicuous. *Dimensions* Length 8.0, width 11.0, depth 1.5 mm.

The two valves of this shell have not been found in conjunction and therefore the placing of the two under one species may not be correct, but this will not affect the specific determination, as that is founded on the pedicle valve. The specimens used for the above description are nontestiferous, as are most of the specimens of shells recovered from the mudstones of the Bowning Beds, and it is from these mudstones our Strophodontas are chiefly obtained, hence they, like the trilobites in general, must have been dwellers in muddy areas.

Loc. and horizon—Minahan's selection, Bowning Creek, about one and a quarter miles NW of Bowning township, Parish of Bowning. Lower Trilobite beds of the Bowning (Bounyongian) Beds.

STROPHODONTA TRANSVERSA, n.sp. (Pl xl, fig. 13)

Pedicle valve (testless) mildly convex, transversely semielliptic, nearly twice as wide as long, hinge-plate narrow, slightly elevated medially; muscular scars indistinct, spines of the latero-cardinal angles of the hinge-plate long and acicular, teeth very small and numerous; little or no trace of radials and punctures is visible. *Dimensions* Length 7.0, width 14.0 mm approximately.

A testless specimen of what appears to be a brachial valve of this species is before me but is fragmentary. It is almost flat, shows traces of a few ribs about $\frac{1}{2}$ mm apart, separated by relatively wide and shallow spaces, muscular scars and cardinal process quite indistinct and in outline similar to the pedicle

valve described above. The outstanding features of the species are its relatively great width, flatness, inconspicuous muscular scars and umbo.

Loc and horizon.—Minahan's selection, Bowning Creek.

STROPHEODONTA SP. INDET. (Pl. xi, fig. 14)

This is represented by a pedicle valve from the Lower trilobite beds of the Bounyongian Beds at Derrengullen Creek. Its features are too vague for determination. It is strongly convex, umbo prominent, radials about forty, hinge-plate produced laterally into spines, teeth small and arranged along the whole length of the plate between the beak and lateral angles.

STROPHEODONTA (BRACHYPRION) LILYDALENSIS Chapman (Pl. xi, fig. 15)

Pedicle valve subquadrate, moderately convex, depressed adjacent to the cardinal angles, radials very numerous, concentric lines indistinct, punctures fine, very numerous and arranged along the interspaces. Muscular area prominent, triangular and large, umbonal slopes prominent and for a short distance from the cardinal area bounded by a row or two of relatively large punctures, a shallow and narrow septum extends from the cardinal margin medially almost to the ventral boundary of the muscular scars, cardinal area narrow; teeth faint and apparently of the *Leptostrophian* type. Lateral margins nearly vertical, anterior rounded and, if a point be taken medially 6 mm from the cardinal margin, the portion anterior to this forms a semicircle. *Dimensions*. Length 18.0, width 24.0 mm, approximately.

The specimen used for the above description is testless. Although there are no spines on the valve now before me extending from the cardinal angles, I am inclined to the opinion that originally such were present.

The resemblances in this to *Stropheodonta (Brachyprion) lilydaleensis* Chapman, are so striking that I place it with that species, they agree in the external features of ribbing, punctation and outline, but in some other respects they differ. Dimensionally Chapman's species is larger than ours and the ratio of length to width is a little different in the two; our specimen is a pedicle valve (cast) and shows rather indifferently the internal features only.

Mr Chapman places his specimen in the subgenus *Brachyprion*. I am inclined to place the New South Wales form with *Leptostrophia*. It may be pointed out also that our fossil occurs in strata older than the limestones of Limestone Creek and much older than the Yeringian, but probably equal in age to some of the lower Melbourne Beds.

Loc and horizon.—Railway cutting about three-quarters of a mile west of Bowning railway station, from rocks near the base of the Bowning Beds. Upper Silurian.

STROPHEODONTA (LEPTOSTROPHIA) QUADRATA, n.sp. (Pl. xi, fig. 16)

Pedicle valve quadrate, mildly and evenly convex. Radials fairly numerous and dichotomising near the margins at least; muscular area and umbo moderately prominent; along the bases of the umbonal slopes are some punctures of larger size than occur elsewhere on the cast. Punctures most numerous and distinct on a zone enclosing the muscular area; outside of this zone they are finer and indistinct. Cardinal area narrow, straight and produced laterally into spines. Hinge-plate narrow and its teeth indistinct. Anterior adductors narrow, diductors large. *Dimensions*. Length 12.0, width 13.0 mm.

This species resembles the preceding one in some respects; but differs from it in being square, less densely punctate and radiate

Loc and horizon—The same as for the preceding species

STROPHODONTA INCERTA, n.sp. (Pl. xli, fig. 17)

Brachial valve (testless) concave, depressed near the cardinal angles and laterally, muscular scars flabellate and indistinct, a very conspicuous septum extends from the cardinal area medially for three parts of the length of the valve. Cardinal area narrow, teeth strong and divergent. Only traces of punctures visible, none of the ribs remain. *Dimensions*: Length 12.5, width 18.75 mm.

The chief reason for giving this specimen specific rank is the presence of the unusual septum which is distinctly different from that observed in other local species. Associated with *S. quadrata* at the same locality.

STROPHODONTA DAVIDI, n.sp. (Pl. xli, figs. 19-21)

Shell concavo-convex, small, subsemicircular.

Brachial valve mildly and evenly concave, radials consisting of thread-like primaries, between each pair of which occurs a secondary and on each side of a secondary is a tertiary interpolation, there seem to be about eight primary ribs on each side of the medial one. Muscular scars circular, the diductors are separated from the adductors by relatively deep septa and outward of these and parallel to them they are further dissected by two to three less distinct ones, adductors narrow and acutely triangular. Muscular area bordered laterally by three or four irregular rows of very distinct punctures, between these and the margins the punctures are very fine, cardinal process simple and prominent. Cardinal area narrow. Hinge-plate as wide as the shell, bearing about twelve to fourteen fine teeth on each side of the beak. Pedicle valve strongly convex, muscular scars prominent, apically divided by a short septum, radiation similar to that of the brachial valve but more distinct, punctation very fine. *Dimensions*: Length 4.48, width 6.63 mm.

This species though small is an interesting one, it seems to be a specialised representative of a group of small Strophodontas, which occur in the Bonnyongian Beds, and in rocks traversed by the upper reaches of the Tarlo River near Crookwell, N.S.W. It occurs associated with numerous Nuculoid species of pelecypods, *Odontopleura jenkinsi*, *O. rattei*, *Ceratocephala (Diceranurus) longispinosa*, *Dalmanites loomessi*.

Loc and horizon—Bowling township, Parish of Bowling. Upper Trilobite beds, Bonnyongian Beds. Probably Lower Devonian, but had, by the late Mr Etheridge and myself, been formerly considered as the uppermost beds of the Upper Silurian system in New South Wales.

Dedicated to Professor Sir Edgeworth David as a small token of appreciation of the great work done by him in elucidating many important problems connected with Australian geology.

STROPHODONTA MINUTA, n.sp. (Pl. xli, figs. 22-25)

Whole shell concavo-convex, semicircular, test thin, laminate and chalky.

Pedicle valve strongly convex. Twelve primary radials distinctly visible and a few near the cardinal angles much less so; the medial pair become three- to

four-forked, and the others two to three as the margins are approached. The punctures are relatively large, of even size and radially arranged along the spaces between the ribs, umbo prominent. Muscular scars indistinct, cardinal area and hinge plate narrow and equal in length to the greatest width of the shell. Brachial valve concave, and in ribbing and punctuation agrees with the pedicle valve. Cardinal area and hinge-plate fairly wide, cardinal process small and simple. Teeth indistinct. *Dimensions* Length 2.25, width 4.5, depth 1 mm.

This species is remarkable for its small size, relative largeness of the punctures adorning the inner surface of the valves, and also for its strong dichotomous ribbing.

Horizon—Bowring and Yass Beds from the Lower Trilobite beds upwards; but is most common in the lower beds.

STROPHODONTA TARLOENSIS, n sp. (Pl. xli, fig. 26)

Whole shell transverse-oblong or sub-semielliptic, concavo-convex, both valves finely and evenly, but not densely punctate, radials of each valve consist of some ten primaries, between each pair of the medial ones four others are interpolated as the margin is approached, and between each pair of lateral primaries two secondaries occur. The pedicle valve is mildly convex, umbo and muscular scars moderately prominent, depressed near the cardinal angles. Hinge-plate linear. Teeth submicroscopic. Brachial valve mildly concave. Cardinal area indistinct with dental sockets distinct and widely divergent, its ribbing similar to that of the other valve. *Dimensions* Length 20, width 50 mm.

In several respects this species resembles the preceding, *S. minuta*, but is shorter, wider, shallower and the punctures of the shell are finer, as also are the ribs; it is easily separable by these differences.

Loc. and horizon—Junction of Back Creek and Tarlo River, Parish of Turrillo, County Argyll, one mile N W of the slate quarry, associated with *Odontopleura hartleyi* and with an undetermined *Encrinurus*. Either Upper Silurian or Lower Devonian, for the present doubtful.

STROPHODONTA BOWNINGENSIS, n sp. (Pl. xlii, fig. 27)

Brachial valve mildly concave, subsemicircular or subquadrate, radials preserved on the median part only, seven or eight relatively strong ones visible, umbonal ridges fairly pronounced, and along their outer edges are rows of five or more, relatively large punctures, and others less regularly placed, the rest of its surface bearing finer punctures, diductor scars strong and ridged, adductor scars narrow and faint, hinge-plate straight, bearing thirty-two or more pectinate teeth. The cardinal area is narrow, and the cardinal process simple and prominent. *Dimensions* Length 50, width 70 (approx.) mm. Pedicle valve unknown.

I am doubtful whether this should not have been placed with *Strophonella*, but the teeth are of the *Strophodont* type.

Loc. and horizon.—Railway cutting about three-quarters of a mile west of the Bowring railway station, from rocks older than the limestones of Limestone Creek, associated with *Atrypa reticularis*, *Encrinurus mitchelli*, *Strophodontella quadrata*, and a *Spirifer* near *Sp. biocostatus* Hall from the Niagara formation of North America.

STROPHODONTA STRIATO-CONTATA, n sp (Pl. xlii., figs 29, 30)

Whole shell nearly semicircular and concavo-convex

Pedicle valve mildly convex, radials consisting of eleven primaries which dichotomise once at an early stage of their growth, and each division bears on its surface several very fine radial striae. In addition to these primaries and their forks, adjacent to the cardinal angles, are some five very fine simple radials. All the primaries and their divisions are superficially depressed, and separated from each other by shallow, narrow, but conspicuous spaces. Concentric striae fine and only visible near the margins. Surface very finely and densely punctate. Muscular scars indistinct and medially divided by a short, narrow, deep slit or septal scar. Umbo not prominent. Cardinal area and hinge-plate narrow and as long as the shell is wide. Teeth very fine and appear to be borne on the greater part of the space between the umbo and the cardinal angles. Brachial valve mildly concave, radials similar to those of the pedicle valve, punctuation indistinct. Hinge-plate fairly wide and of low triangular shape, resembling that of some *Plectambonites*. Teeth in part arranged on low knife-edged ridges extending from each side of the cardinal process about half-way to the cardinal angles. Cardinal process indistinct. *Dimensions* Length 3.45, width 6.8 mm.

This is another small *Stropheodonta*, and seems to be confined to the uppermost beds of the Bounyongian Beds.

STROPHODONTA STRIATO-PUNCTATA, n sp (Pl. xlii., fig 31)

Pedicle valve very mildly convex, radials consist of very numerous and fine striae, punctures fine and numerous, umbo inconspicuous and divided by a short slit-like septum, hinge-plate narrow and as wide as the valve. *Dimensions* Length 6.0, width 8.0 mm. Brachial valve unknown.

The unusually numerous and fine radial striae and punctures separate this species from all others which have come under my notice.

Loc and horizon.—The same as for *Stropheodonta davidi*.

STROPHODONTA FRAGILIS, n sp (Pl. xlii., figs 32, 33)

Pedicle valve truncato-discoidal and very mildly convex, radials consist of about eighteen primaries with some interpolations near the ventral margin, thread-like, interspaces wide and shallow, umbo inconspicuous and under the test is mildly bifid; muscular area depressed, hinge-plate narrow and produced laterally, punctures fine and arranged in two to three irregular rows within the interspaces, hinge-plate narrow, laterally produced into long spines, teeth small, nine or ten visible on the right-hand side, where the test is absent. *Dimensions*. Length 10.0, width 11.0 mm.

Loc and horizon.—Minahan's selection, Bowning Creek, one and a half miles N.W. of Bowning township.

This *Stropheodonta* agrees dimensionally with *Brachyprion leda* Bill, but its processes extending from the cardinal angles are very much longer and finer and its teeth are more numerous, spread over a greater area of the hinge-plate, and smaller, the hinge-plate is narrower. It certainly does not belong to the *Brachyprion* group.

EXPLANATION OF PLATES XXXIX-XLII

Plate xxxix

(Figures enlarged 2½ or more times)

Fig 1-2—*Stropheodonta bendinensis* Mitchell

1 A testless pedicle valve showing the muscular area umbo and vascular system 2. Another pedicle valve of the same species, showing the muscular scars, puncturation, vascular system in part and a portion of one of the spines, extending from the left cardinal angle

Fig 3—*Stropheodonta silverdalensis* Mitchell

A front view of a pedicle valve showing strong convexity, fine radiation and punctures

Figs 4-8—*Stropheodonta borsoides* Mitchell

4 A pedicle valve showing the fine radials, punctures etc

5 A brachial valve of the preceding, showing the hinge-plate and fine teeth faintly, and some of the radials

6-8 Pedicle valves of the same

Fig 7 represents a perfect valve which shows a complete hinge-plate and small teeth

Plate xl (Figures much enlarged)

Fig 9 *Stropheodonta borsoides* Mitchell

Shows the radials and acicular processes of the cardinal angles of a pedicle valve

Fig 10—*Stropheodonta conica* Mitchell

A pedicle valve showing the ribbing processes of the hinge-plate and outline

Fig 11—*Stropheodonta phalænoides* Mitchell

A perfect testless valve, in which the main features are visible

Fig 12—*Stropheodonta bendinensis* Mitchell

A good photo of a testless pedicle valve (x 4) The shell above it is *S. minuta*

Fig 13—*Stropheodonta transversa* Mitchell

A testless brachial valve

Fig 14—*Stropheodonta*, sp. indetFig 15—*Stropheodonta (Brachyprion) lilydalensis* Chapman

Pedicle valve (testless), shows clearly the numerous fine radials, the densely punctate surface, muscular scars and median septum

Fig 16—*Stropheodonta quadrata* Mitchell

Shows the muscular scars, absence of median septum, the large punctures along the base of each umbonal ridge and the finer punctures on the rest of the surface

Plate xli (Figures enlarged, some 9 times)

Fig 17.—*Stropheodonta incerta* Mitchell

A pedicle valve (?), showing the pronounced median septum, punctures and outline

Fig 18—*Stropheodonta bendinensis* Mitchell

A pedicle valve with test partly preserved and showing it to consist of three layers, the middle bears the punctures and the under layer carries short spines which fit into the punctures of the layer above, and which are plainly shown, the ribs are also visible

Figs 19-21 — *Stropheodonta davidi* Mitchell

19 A brachial valve, internal view, showing the important structural features

20 A pedicle valve of the same, showing the large muscular scars

21 Another specimen, showing the valves open and conjoined by the hinge

Figs 22-25 — *Stropheodonta menuta* Mitchell

22 A view of the open valves joined along the hinge, the valves are testless and show the features clearly

23-25 Specimens of the same species and show pedicle and brachial valves, 23 is partly testiferous.

Fig 26 — *Stropheodonta tarloensis* Mitchell

Pedicle and brachial valves joined along the hinge. The primary and finer intermediate radials, the punctures and strong muscular scars of the pedicle valve are clearly though faintly visible

Plate xli (Some of the figures are enlarged 6 times or more)

Fig 27 — *Stropheodonta downingensis* Mitchell

An interior view of a brachial valve, showing the important features rather well

Fig 28 — *Stropheodonta phalaenoides* Mitchell

A brachial valve showing the radials, concentric striae, hinge processes, etc

Figs 29-30 — *Stropheodonta striato-costata* Mitchell

29 A brachial valve showing the radials, striae, punctures, hinge-plate and teeth

30 The two valves of the same species, open and joined by their hinges, they show the radials fairly well and the radial striae and punctures faintly

Fig 31 — *Stropheodonta striato-punctata* Mitchell

A pedicle valve showing the crowded punctures and short median septum, and the radial striae faintly

Figs 32-33 — *Stropheodonta fragilis* Mitchell

32 A pedicle valve showing the radials, fine punctures, slightly bifid beak (cast of) and teeth on the hinge-plate

33 Another pedicle valve of the above to show the processes of the cardinal angles

THE HIGH TEMPERATURE ORGANISM OF FERMENTING TAN-BARK.

Part III

By R GREGG-SMITH, D Sc, Macleay Bacteriologist to the Society

(One Text-figure)

[Read 26th September, 1923]

In the earlier part of the work upon the high temperature organism, it was found that the fluid media which had been used were badly adapted to the growth of the bacterium. As much useful information regarding the physiological activities of bacteria can be obtained by the use of fluid cultures, it was considered advisable to investigate the growth in fluids more closely.

Many cross tests pointed to a fluid in which the bacteria grew very well. It had the following composition: Peptone 0.5%, anhydrous magnesium sulphate 0.1%, hydrated sodium phosphate 0.2% and a source of carbon such as saccharose. An alternative formula consisted of ammonium sulphate 0.5%, potassium citrate 0.3%, sodium phosphate 0.2%, magnesium sulphate 0.1% and a source of carbon. The combination of ammonium sulphate and potassium citrate was necessary for without the citrate there was no growth of the bacillus. Of all the salts that were tested the magnesium salt was most necessary. An alternative ammoniacal culture fluid, and one which ultimately proved better than the last, contained ammonium phosphate 0.5% which replaced the ammonium and the sodium salts.

The peptone culture fluid was used in an experiment to test the fermentability of saccharose. Two sets are recorded each with 2% of the sugar. The second set is confirmatory to the first, which shows that the control without sugar gave as much carbon dioxide as the test and, although the control was slow to start, yet by the seventh day it gave more.

Table I Carbon dioxide in mgrms Aggregate amounts

Days	3	5	4	5	6	7	9	10	13	16	20
Saccharose	17	39	47	54	—	63					
Control	—	5	13	29	—	69					
Saccharose	8	11	20	—	39	46	63	68			
Control	4	16	38	—	62	84	116	132	165	179	187

As the controls, sooner or later, gave more carbon dioxide than the saccharose tests, it is evident that something other than saccharose was being fermented. The only other possible source of carbon in the fluids was peptone and this had undoubtedly been fermented. But the saccharose in the sugar tests was also attacked, for the media which had been coloured with brom-thymol blue rapidly became yellow and the acid condition seemed to preclude the production

of carbon dioxide. The neutralisation of the culture fluid made only a temporary alteration for the neutral solution rapidly became acid. The control fluids maintained their grass-green colour.

Since peptone had proved to be a disturbing factor, it was replaced by ammonium sulphate and potassium citrate as in the alternative formula.

When dextrin was added in the proportion of 15 grams to 30 c.c. of nutritive fluid, a comparatively rapid fermentation set in. The fluid became acid, pH 5.8, and it was neutralised on the 7th, 12th, 16th, 19th and 28th days. Subsequent to each neutralisation, the yield of carbon dioxide was considerably increased.

Table II. The Fermentation of Dextrin. Carbon dioxide in mgrms.

Days	2	3	4	7	10	12	14	16	18	19	21	25	28	30	31
Aggregate yield	11	42	55	62	94	116	149	179	237	286	405	437	450	494	526

Following the dextrin experiment, one was made to determine the fermentability of saccharose. The fluid was neutralised on the 4th and 11th days and doubtless, if it had been neutralised more frequently, the numbers would have been greater. The matter of the frequent neutralisation was tested with dextrose, two flasks being used, one of which was neutralised at each determination and the other was not. Both were neutral at the start.

Table III. The Fermentation of Saccharose and of Dextrose. Carbon dioxide in mgrms.

Days	1	2	4	5	6	7	8	9	10	11	12	13	15
Saccharose	10	—	16	—	21	—	—	80	92	104	114	120	136
Dextrose neutralised	8	15	27	38	50	69	84	92	—	115	—	—	—
Dextrose not neutralised	7	11	11	14	15	—	—	—	—	18	—	—	—

It is clear from the dextrose portion of the experiment that a daily neutralisation of the fermenting fluid is necessary. On the 11th day, when the test was concluded, both dextrose fluids had an acidity of pH 5.6 which also was the acidity of the daily neutralised fluid on the 9th day and of the un-neutralised fluid on the 11th. From this we learn that in the fermentation of dextrose, the bacteria soon develop a definite amount of acid and then cease to act.

It has been seen that the use of peptone was prohibited in these experiments on account of its fermentability and recourse was made to ammonium sulphate as a source of nitrogen. It was expected that asparagin would also be fermentable and, when occasion arose, the matter was put to the test. A Uschinsky fluid without asparagin was prepared and 30 c.c. portions were put into two flasks. One received 0.15 gram of asparagin, the other 0.15 gram of ammonium sulphate. The fluids were brought to pH 7 daily, the fermenting asparagin with normal sulphuric acid, the other with dilute ammonia.

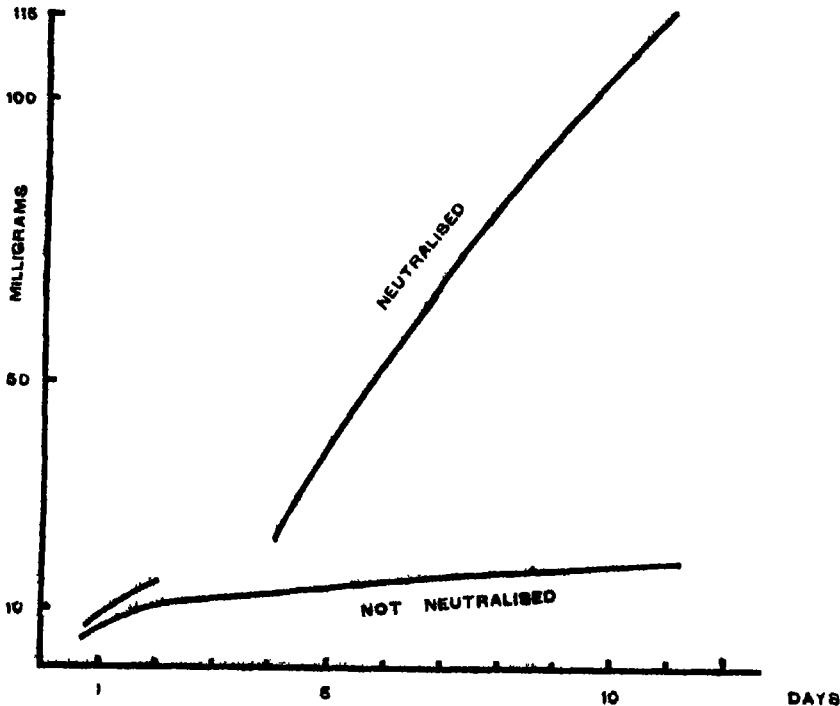
Table IV. The Fermentation of Asparagin. Aggregate yield in mgrms.

Days	4	8	9	10
Ammonium sulphate	2	—	—	4
Asparagin	3	16	29	54

It is clear that asparagin is fermentable. The active production of carbon dioxide began about the seventh day.

In my first paper (These Proceedings, 1921, pp. 90 and 98) it was suggested that in order to get a very active fermentation of tan-bark, the addition of a nitrogenous nutrient was necessary. This followed upon obtaining an increased yield of carbon dioxide after the addition of asparagin. As, however, asparagin is itself fermentable, the increase must be credited to it and not to the tan-bark.

The experiments with saccharose, dextrose and dextrin in Tables II and III, as well as others which have not been recorded, were faulty on account of the presence of potassium citrate which under certain conditions is fermented by the bacillus. The quantity of citrate in the culture fluid in each case was 0.09 gram which could give a theoretic yield of 73 mgrms of carbon dioxide. As the yields in Tables II and III were more than this, it follows that saccharose, dextrose and dextrin were fermented.



Text-fig 1--The fermentation of Dextrose

Some of the commonly occurring carbohydrates and sources of carbon were then examined for fermentability. A Uchinsky fluid containing 0.5% of ammonium sulphate in place of asparagin was prepared and 30 cc were put into fermentation flasks with 0.1 gram of the source of carbon. The flask contained no carbon compound other than that under examination. The time during which each test was permitted to go was just enough to show whether the substance was capable of being fermented or not.

The fermentation of raffinose and of inulin was continued beyond the seventh day. On the eighth day each flask was given 2 grams of kieselguhr and was re-seeded. Ten days later, the carbon dioxide was determined, the inulin reached a total of 26, the raffinose a total of 19 mgrms. Both these substances fermented very slowly. Inulin, when heated at 200° as in the dextrination of starch, was not rendered any more fermentable.

Lactose gave a slow but steady production of carbon dioxide and should lend itself to certain work where a retarded fermentation is desired. The fermentation of dextrin is included in the table although the figures are taken from Table II.

Table v The fermentation of various sources of Carbon
carbon dioxide in mgrms

Days	1	2	3	4	5	7
Control	—	—	—	1	—	3
Saccharose	8	29	—	—	—	—
Dextrose	—	22	—	—	—	—
Levulose	—	11	—	37	—	—
Maltose	—	7	—	28	—	—
Lactose	—	—	—	16	31	—
Galactose	14	27	—	—	—	—
Raffinose	—	—	4	—	—	9
Xylose	—	15	46	—	—	—
Gum acacia	12	22	34	—	—	—
Mannit	—	19	—	—	—	—
Glycerin	—	11	—	73	—	—
Dextrin	—	11	42	55	—	—
Inulin	—	8	—	—	—	12
Insulin heated	—	10	—	—	—	16
Starch, raw	—	7	9	—	11	—
Starch, gelatinised	—	11	38	64	87	—
Starch, dextrinised	—	13	26	36	—	—
Soluble starch, raw	—	—	5	—	6	—
Soluble starch, diffused	—	19	33	48	66	—

Commercial starch, a mixture of maize with some potato starch, was tested in the raw and in the gelatinised condition. It had been tested upon a previous occasion when suspended in a peptone fluid and, as the carbon dioxide evolved had been similar to the peptone control, it was considered that the starch had not been attacked. The present figures show that this was not the case, it is fermentable and as one would expect, it is more readily attacked in the jellyfied than in the granular condition. The same applies to Landner's soluble starch which was tested in the compact or raw state and after having been diffused by boiling in the 30 c.c. of nutritive fluid.

When examining the fermenting liquid containing starch and dextrin, the bacteria were seen to be actively motile. Up to that time the motility had not been noted although many films had been examined and it was known that the cells were covered with peritrichous flagella. Fluids containing these carbohydrates were slow to become acid and the neutral condition probably favoured the motility of the organism.

The trisatomic alcohol, glycerin, and the hexatomic alcohol, mannit, were readily attacked and it seemed probable that other alcohols would be fermented. Believing that ethyl alcohol would be too easily expelled from the fermentation apparatus which is maintained at a temperature of 18° below the boiling point of the alcohol, a test was made with amyl alcohol. Two flasks, each containing 30 c.c. of ammonium phosphate saline, received 0.1 and 0.5 c.c. of fusel oil and were seeded with the bacillus. Most of the alcohol was quickly carried over by the current of air into the barvta water and fresh additions were made to the flasks on the 3rd, 5th and 9th days. A good growth of bacteria formed in the flasks but, in the case of the larger quantity of fusel oil, it seemed that most of it had to be vaporised and carried away before fermentation would proceed. It seemed to act as a mild antiseptic.

At a later date, ethyl alcohol was tested, the volatilisation being limited by permitting the air to pass slowly through the fermenting flask.

Table vi The Fermentation of Ethyl and Amyl Alcohols
in mgrms of carbon dioxide

Days	2	3	4	5	6	9	13
Fusel oil, 0.1 c.c.	3	—	8	14	20	36	36
Fusel oil, 0.5 c.c.	6	—	10	14	18	—	—
Ethyl alcohol, 1 c.c.	23	44	—	—	—	—	—

From the behaviour of mannit, glycerin and these alcohols it is seen that the alcoholic structure of the molecule is easily attacked by the bacterial enzymes.

Since citrate had been found to be fermentable it seemed probable that other organic acid salts would also be attacked and such was found to be the case. Two exceptions were oxalate and formate which were not fermentable and repetitions of the tests confirmed their non-fermentability. The following sodium or ammonium salts were added in the proportion of 0.2 gram to 30 cc of an ammonium phosphate saline solution and each test received a gram of purified fuller's earth as an accelerator.

Table vii. Fermentability of organic salts		Carbon dioxide in mgrms.			
	Days	1	2	3	4
Acetate		11	32	—	—
Oxalate		—	—	—	2
Succinate		14	31	—	—
Lactate		10	+	+	42
Formate		—	—	—	2

In Part I of this series it was recorded that urea, meat-extract and ammonia were useless as sources of nitrogen, but it was also noted that ordinary fluid media were not suited for the growth of the bacteria. The utilisation of the nutrients had been tested in unsuitable media and that accounted for the erroneous statement regarding ammonia. The tests made at the beginning of the present paper showed that much depended upon a favourable adjuvant which was found in a salt of magnesium.

Again the method of testing the activity of the bacterium by estimating the quantity of carbon dioxide evolved is much more refined than the method of noting the gas, if any, caught in a glass tube inverted and submerged in a larger tube of fluid medium. Especially is it so with this organism for the high temperature rapidly expels the carbon dioxide from the liquid and renders the method unsatisfactory when the fermentation is slow.

It has been shown that ammonia can serve as a source of nitrogen and, in view of the general power of the bacillus to break up molecules containing carbon, it is probable that meat-extract will be found to be easily attacked and the carbon utilised. It is not so easy to foretell the probable fate of urea.

A fifth of a gram of meat-extract was put into a flask containing 30 cc of a solution containing 0.2% of sodium phosphate and 0.1% of anhydrous magnesium sulphate. As an accelerator, 0.2 gram of purified fuller's earth was added. Fermentation quickly set in and 36 mgrms were obtained in 24 hours. Clearly meat-extract can serve as a source of nitrogen.

A similar experiment was made with urea but there was only a feeble fermentation. Five mgrms. were obtained in five days and, upon the fluid being re-seeded, another three mgrms. were caught by the eighth day. The idea occurred that this was not a fair test for determining whether or not urea was capable of serving as a source of nitrogen. It was rather a test to see if it could be a source of carbon and nitrogen. Accordingly two further tests were made, in one of which 0.2 gram of urea was added to the saline fluid together with 0.2 gram of saccharose. As a control the saline fluid of the second test received saccharose only. Both were given fuller's earth.

The urea and saccharose gave 24 mgrms of carbon dioxide on the first day and a total of 72 mgrms. on the second, while the test with saccharose only yielded 3 mgrms. by the second day. Urea can undoubtedly serve as a source of nitrogen.

The saccharose-plus-urea test was examined for ammonia. The baryta water-

trapping flask contained 0.3 mgrm and the fermenting fluid on the second day, when distilled with a gram of magnesium oxide, yielded 60 mgrm of ammonia. This seems to indicate that among its other accomplishments the bacterium can secrete a urease capable of converting urea into ammonia.

Conclusions

The high temperature organism in suitable fluid media is capable of producing carbon dioxide from quite a number of sources of carbon. These included.

Carbohydrates such as saccharose, dextrose, levulose, maltose, lactose, galactose, xylose, dextrin, starch and gum acacia.

Alcohols such as mannit, glycerin, amyl and ethyl alcohols.

Salts of organic acids such as citric, lactic, succinic and acetic.

Nitrogenous substances such as peptone, meat-extract and asparagin.

Ammonium salts and urea can serve as sources of nitrogen.

Raffinose and inulin are scarcely fermented.

Oxalates and formates are not attacked.

I am indebted to Mr W W L'Estrange for much kindly assistance.

MESOZOIC INSECTS OF QUEENSLAND

No 10 SUMMARY OF THE UPPER TRIASSIC INSECT FAUNA OF IPSWICH, Q (With an Appendix describing new Hemiptera and Planipennia)

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(Plate xlii, figs 38-40, Text-figs 90-93)

[Read 31st October, 1923]

With the addition of a few forms dealt with as an Appendix to this paper, the publication of Mr Dunstan's work on the Coleoptera (1923) brings to a close the work on the extensive collections of Upper Triassic fossil insects found at Denmark Hill, Ipswich, Q. We are, therefore, now in a position to summarize these results, and to draw conclusions from them as to the age of the beds and the composition of the fauna disclosed in them. With this end in view, I propose to give, first of all, a complete list of the Orders, families, genera and species described from Ipswich, and then to discuss the results. The list here given differs slightly from the detailed results as published in the various parts, as follows —

(1) After further study of the Order Protodonata, I am unable to admit the retention of the genus *Aeroplana* in this Order. This type of wing appears to be a highly specialised offshoot from the old Palaeodictyoptera, showing some affinities with the Protorthoptera on account of the structure of the much simplified radial sector and the many-branched media. I propose, therefore, to treat the Aeroplanoptera as a distinct Order rather than as a Suborder of the Protodonata.

(2) Two new species of *Triassocoris* and a new genus and species belonging to the Order Neuroptera-Planipennia are described in the Appendix to this paper, and are included in the list, bringing the total number of species up to 122, belonging to 63 genera, 32 families, and 10 Orders, as shown in the following list. Genotype species are marked with an asterisk. For references, see bibliography at end of this paper.

List of Fossil Insects from the Upper Triassic Beds of Denmark Hill, Ipswich, Q

Order AEROPLANOPTERA.

Family Aeroplanidae.

Genus *AEROPLANA* Till., 1918b, p. 426.

**Aeroplana mirabilis* Till., 1918b, p. 426.

Order ODONATA

Sub-order *Archzygoptera*

Family Triassagrionidae

Genus TRIASSAGRION Till, 1922, p 455

**Triassagrion austrahense* Till, 1922, p 456Sub-order *Amsozygoptera*

Family Mesophlebiidae

Genus MESOPHLEBIA Till, 1916, p 24, 1922, p 452.

**Mesophlebia antinodula* Till, 1916, p 25, 1922, p 452

Genus TRIANOPHLEBIA Till, 1922, p 454

**Triasnophlebia stigmatica* Till, 1922, p 454

Family Triassolestidae

Genus TRIASSOLESTES Till, 1918b, p 418

**Triassolestes epiphlebioides* Till, 1918b, p 419

Incertae sedis

Genus PERISNOPHLEBIA Till, 1918b, p 422

**Perisnophlebia multiseriata* Till, 1918b, p 424

Order PROTORTHOPTERA

Family Mesorthopteridae

Genus MESORTHOPTERON Till, 1916, p 14, 1922, p 448

**Mesorthopteron locustoides* Till, 1916, p 14, 1922, p 448

Family Mesomantididae

Genus MESOMANTIDION Till, 1916, p 16

**Mesomantidion queenslandicum* Till, 1916, p 16

Order ORTHOPTERA

Sub-order *Blattoidea*

Family Mylacridae

Genus AUSTROMYLACRITES Till, 1916, p 13

**Austromylacrites latus* Till, 1916, p 13

Family Mesoblattinidae

Genus TRIANOBBLATTA Till, 1919b, p 367

**Triassoblatta typica* Till, 1919b, p 368*Triassoblatta insignita* Till, 1919b, p 370*Triassoblatta* (?) *intermedia* Till, 1919b, p 371

Genus SAMAROBLATTA Till, 1919b, p 373

**Samaroblatta reticulata* Till, 1919b, p 374*Samaroblatta triassica* Till, 1919b, p 375*Samaroblatta jonesi* Till, 1919b, p 376*Samaroblatta blattelloides* Till, 1919b, p 377.*Samaroblatta intercalata* Till, 1919b, p 379

Genus AUSTRUBLATTULA Till, 1919b, p 380.

**Austroblattula ipaviciensis* Till, 1919b, p 381Sub-order *Mantodea*.

Family Triassomantidae

Genus TRIASSOMANTIS Till, 1922, p 450

**Triassomantis pygmaeus* Till, 1922, p 450

Sub-order *Locustodea*.

Family Locustopsidae

Genus TRIASSOLOCUSTA Till, 1922, p 451

**Triassolocusta leptoptera* Till, 1922, p 451

Order HEMIPTERA

Sub-order Homoptera

Family Mesogereonidae

Genus MESOGEREON Till, 1916, p 33, 1921, p 273

**Mesogereon neuropunctatum* Till, 1916, p 34, 1921, p 273*Mesogereon superbum* Till, 1921, p 274*Mesogereon compressum* Till, 1921, p 277*Mesogereon affine* Till, 1921, p 277*Mesogereon shepherdis* Till, 1921, p 279

Family Cicadellidae

Genus MESOJASSUS Till, 1916, p 34, 1920, p 885

**Mesojassus ipsviciensis* Till, 1916, p 35, 1920, p 886

Genus EURYMELIDIUM Till, 1920, p 884

**Eurymelidium australe* Till, 1920, p 885

Genus TRIASSOJASSUS Till, 1920, p 887

**Triassojassus proavitus* Till, 1920, p 888

Family Scytinopteridae

Genus MESOSCYTINA Till, 1920, p 871

**Mesoscytina australis* Till, 1920, p 871*Mesoscytina affinis* Till, 1920, p 872

Genus TRIASSOSCARTA Till, 1920, p 874

**Triassoscarta subcostalis* Till, 1920, p 874

Genus APHELOSCYTA Till, 1922, p 458

**Apheloscyta mesocampa* Till, 1922, p 459

Genus CHILIOCYCLA Till, 1920, p 868, 1922, p 460

**Chiliocycla scolopoides* Till, 1920, p 869, 1922, p 460

Genus POLYCYTELLA Till, 1922, p 460

**Polycytella triassica* Till, 1922, p 460

Family Tropiduchidae

Genus MESODIPHTHERA Till, 1920, p 873; 1922, p 461

**Mesodiphthera grandis* Till, 1920, p 873*Mesodiphthera prosboloides* Till, 1922, p 461*Mesodiphthera dunstani* Till, 1922, p 462

Family Cixiidae

Genus MESOCIXIUS Till, 1920, p 876

**Mesocixius triassicus* Till, 1920, p 877

Genus TRIASSOCIXIUS Till, 1920, p 878

**Triassocixius australe* Till, 1920, p 878

Genus MESOCIXIODES Till, 1922, p 462

**Mesocixiodes termoneura* Till, 1922, p 462*Mesocixiodes orthoclada* Till, 1922, p 463*Mesocixiodes brachyclada* Till, 1922, p 463

Family Ipsiviidae

Genus IPSIVIA Till, 1920, p 878

**Ipsivia jonesi* Till, 1920, p 879*Ipsivia maculata* Till, 1920, p 881.

Ipsucia acutipennis Till, 1920, p 883

Genus IPSUVICIOPSIS Till, 1922, p 464

**Ipsuviciopsis elegans* Till, 1922, p 464

Ipsuviciopsis magna Till, 1922, p 465

Sub-order *Heteroptera*

Family Dunstanidae

Genus DUNSTANIA Till, 1916, p 31, 1918c, p 583

**Dunstania pulchra* Till, 1916, p 32, 1918c, plate

Genus DUNSTANIOPSIS Till, 1918c, p 584

**Dunstaniopsis triassica* Till, 1918c, p 585

Genus PARADUNSTANIA Till, 1918c, p 585

**Paradunstania affinis* Till, 1918c, p 586

Family Triassocoridae

Genus TRIASSOCORIS Till, 1922, p 466

**Triassocoris myersi* Till, 1922, p 466

Triassocoris scutulum Till, 1922, p 467

Triassocoris ovalis n sp

Triassocoris (?) *grandis* n sp

Order PROTOMECOPTERA

Family Archipanorpidae

Genus ARCHIPANORPA Till, 1917, p 191

**Archipanorpa magnifica* Till, 1917, p 191

Order MECOPTERA

Family Choristidae

Genus MESOCHORISTA Till, 1916, p 29

**Mesochorista proavita* Till, 1916, p 30

Family Stereochoristidae

Genus STEREOCHORISTA Till, 1919a, p 196

**Stereochorista frustrata* Till, 1919a, p 197

Order PARATRICHOPTERA

Family Mesopsychidae

Genus MESOPSYCHE Till, 1917, p 181

**Mesopsyche triareolata* Till, 1917, p 182

Genus TRIASSOPSYCHE Till, 1917, p 182

**Triassopsyche dunstan* Till, 1917, p 184

Genus ARISTOPSYCHE Till, 1919a, p 200

**Aristopsyche superba* Till, 1919a, p 202

Genus NEUROPSYCHE Till, 1919a, p 203

**Neuropsyche elongata* Till, 1919a, p 204

Order NEUROPTERA

Sub-order *Planipenna*

Family Prohemerobiidae

Genus PROTOPSYCHOPSIS Till, 1917, p 178

**Protopsychopsis venosa* Till, 1917, p 180

Genus OSMYLOPSYCHOPS, n g

**Osmylpsychops spilleras*, n sp.

Family Psychopsidae

Genus ARCHEPSYCHOPS Till, 1919a, p 205

- **Archepsychops trassica* Till, 1919a, p 206
 Genus *TRASSOPSYCHOPS* Till, 1922, p 467
 **Trassopsychops superba* Till, 1922, p 469

Order COLEOPTERA

Family Hydrophilidae

- Genus *ADEMOSYNE* Handl, 1906, p 402
 **Ademosyne major* Handl, 1906, p 402, Till, 1916, p 19, Dunst, 1923, p 15
Ademosyne olliffi (Handl), 1906, p 402, Till, 1916, p 19, Dunst, 1923, p 12
Ademosyne australensis Till, 1916, p 18, Dunst, 1923, p 19
Ademosyne congener Till, 1916, p 20, Dunst, 1923, p 22
Ademosyne cameroni Till, 1916, p 21, Dunst, 1923, p 24
Ademosyne punctata Till, 1916, p 21, Dunst., 1923, p 23.
Ademosyne parva Dunst, 1923, p 13
Ademosyne intermedia Dunst, 1923, p 14
Ademosyne lata Dunst, 1923, p 15
Ademosyne brevis Dunst, 1923, p 17
Ademosyne curvata Dunst, 1923, p 18.
Ademosyne ramocostata Dunst, 1923, p 19
Ademosyne rugulosa Dunst, 1923, p 20
Ademosyne vittamargina Dunst, 1923, p 21
Ademosyne adunca Dunst, 1923, p 23.
 Genus *ADEMOSYNODES* Dunstan, 1923, p 25
 **Ademosynoides minor* (Handl), 1906, p 403, Till, 1916, p 20, Dunst, 1923, p 26
Ademosynoides obtusa (Till), 1916, p 19; Dunst, 1923, p 26
Ademosynoides angusta (Till), 1916, p 18, Dunst., 1923, p 29.
Ademosynoides alternata Dunst, 1923, p 27
Ademosynoides striatella Dunst, 1923, p 28
Ademosynoides abnormis Dunst, 1923, p 30.
Ademosynoides magnifica Dunst, 1923, p 31
 Genus *PLATYROSSOS* Dunstan, 1923, p 32.
 **Platycrossos tumidus* (Till.), 1916, p 21, Dunst, 1923, p 34.
Platycrossos ligulatus Dunst, 1923, p 33
Platycrossos subtumidus Dunst, 1923, p 34
 Genus *SRIMMONDSIA* Dunstan, 1923, p 35
 **Srimmondsia subpyriformis* Dunst., 1923, p 36
Srimmondsia cylindrica Dunst., 1923, p 37
 Genus *GRAMMOSITUS* Dunstan, 1923, p 37.
 **Grammositus bilineatus* Dunst, p. 38
 Genus *SHEPHERDIA* Dunstan, 1923, p 38
 **Shepherdia quadrivittata* Dunst., 1923, p 39
 Genus *POLYSITUS* Dunstan, 1923, p 40
 **Polysitus punctatus* Dunst., 1923, p 40.
Polysitus minutus Dunst., 1923, p 42

Family Tenebrionidae (?)

- Genus *ULOMITES* Till., 1916, p 22
 **Ulomites wilcoxi* Till, 1916, p. 22, Dunst, 1923, p. 43

Family Elateridae (?)

Genus ELATERIDIUM Till, 1918a, p 751

Elateridium subulatum (Dunst), 1923, p 44*Elateridium transversum* (Dunst), 1923, p 45

Genus ELATERIUM Westwood, 1854 (Quart Journ Geol Soc, x, p. 387).

Elaterium punctomarginum Dunst, 1923, p 46*Elaterium bipunctatum* Dunst, 1923, p 47

Family Dermestidae (?)

Genus REEVEANA Dunstan, 1923, p 48

**Reeveana major* Dunst, 1923, p 48*Reeveana intermedia* Dunst, 1923, p 49*Reeveana minor* Dunst, 1923, p 50

Genus TRYONIOPSIS Dunstan, 1923, p 51

**Tryoniopsis punctata* Dunst, 1923, p 51*Tryoniopsis granulata* Dunst, 1923, p 52

Family Buprestidae (?)

Genus MESOSTIGMODERA Eth & Oll. 1890, p 10, Handl, 1906, p 402

**Mesostigmodera typica* Eth & Oll, 1890, p 10, Handl, 1906, p 402,
Till, 1916, p 22, Dunst, 1923, p 56

Genus LOBITES Dunstan, 1923, p 53

**Lobites tuberculata* Dunst, 1923, p 54*Lobites trivittata* Dunst, 1923, p 53*Lobites granulata* Dunst, 1923, p 55

Family Cerambycidae (?)

Genus MESOTHORIS Till, 1916, p 23

**Mesothoris clathrata* Till, 1916, p 23, Dunst, 1923, p 58*Mesothoris quadripuncta* Dunst, 1923, p 60*Mesothoris tenuiclathrata* Dunst, 1923, p 61*Mesothoris grandis* Dunst, 1923, p 61.

Genus WILLOOXIA Dunstan, 1923, p 62

**Willookia magnopunctata* Dunst, 1923, p 63

Family Curculionidae (?)

Genus ETHERIDGEA Handl, 1906, p 402

**Etheridgea australis* Handl, 1906, p 402, Till, 1916, p 24, Dunst.,
1923, p 68

Genus TILLYARDIOPSIS Dunst., 1923, p 64

**Tillyardiopsis tuberculata* Dunst, 1923, p 65*Tillyardiopsis granulata* Dunst., 1923, p 66*Tillyardiopsis variotubercula* Dunst, 1923, p 67

Family Dascillidae (?)

Genus LEOODES Dunstan, 1923, p 68

**Leoodes plana* Dunst, 1923, p 69*Leoodes pygmaea* Dunst, 1923, p 69

Genus APHELOODES Dunstan, 1923, p 70

**Apheloodes obliqua* Dunst., 1923, p 72*Apheloodes rugosa* Dunst, 1923, p 71

The composition of the above fauna is summarised in Table A

Table A
Table Showing the Numerical Composition of the Fauna

Orders and Suborders	Families	Genera	Species	Percentage of Species
Hemimetabolous Orders				
Aeroplanoptera	1	1	1	0.8
Odonata	3	4	4	3.3
Protorthoptera	2	2	2	1.6
Orthoptera	4	6	12	9.8
{ Blattoidea	2 }	4 }	10 }	8.2 }
{ Mantodea	1 }	1 }	1 }	0.8 }
{ Locustoidea	1 }	1 }	1 }	0.8 }
Hemiptera	8	19	34	27.9
{ Homoptera	6 }	15 }	27 }	22.2 }
{ Heteroptera	2 }	4 }	7 }	5.7 }
Holometabolous Orders				
Protomecoptera	1	1	1	0.8
Mecoptera	2	2	2	1.6
Paratrachoptera	1	4	4	3.3
Neuroptera Planipennia	2	4	4	3.3
Coleoptera	8	20	58	47.6
Total (10 orders) —	32	63	122	100.0

Percentage of species of Hemimetabola — 43.4

Percentage of species of Holometabola — 56.6

The Geological Age of the Ipswich Beds

The composition of the Insect Fauna of the Ipswich Fossil Beds affords very valuable evidence of the geological age of these beds. In order to make this evidence clear, I give below a Table (Table B) comparing the percentages of the various Orders in the Ipswich Beds with those of the Belmont Beds, which are undoubtedly of Upper Permian Age, and the Liassic Beds of Europe. It will also be necessary to trace the evolution of certain test groups of insects to show how the percentage of such groups may be used as an aid in indicating the comparative ages of the beds.

Table B

Table showing the Ordinal Percentages in the Belmont, Ipswich and European Liassic Insect Faunas

Orders and Suborders	Belmont	Ipswich	Liassic of Europe
Hemimetabolous Orders			
Aeroplanoptera	—	0 8	—
Odonata	—	3 3	5 2
Protorthoptera	—	1 6	—
Orthoptera	—	9 8	26 5
{ Blattoidea	—	8 2	7 4
{ Mantodea	—	0 8	2 5
{ Locustoidea	—	0 8	16 6
Hemiptera	47 4	27 9	9 6
{ Homoptera	47 4	22 2	7 4
{ Heteroptera	0 0	5 7	2 2
Holometabolous Orders			
Neuroptera Planipennia	5 3	3 3	4 3
Protomecoptera	5 3	0 8	—
Mecoptera	21 0	1 6	4 6
Parametoptera	10 5	—	—
Paratrachoptera	—	3 3	—
Diptera	—	—	4 0
Trichoptera	—	—	4 0
Coleoptera	10 5	47 6	41 8
	100 0	100 0	100 0
Percentage of Hemimetabola	47 4	43 4	41 3
Percentage of Holometabola	52 6	56 6	58 7

NB—The above percentages are calculated on the following total numbers of species for each fauna—Belmont, 19, Ipswich, 122; Laas, 324. The Laas includes both Lower and Upper Laas, together with some Rhaetic fossils, reckoned by Handlirsch as Lower Laas. The record of the European Triassic is too small and fragmentary to be of any use.

Referring to Table B, the following groups may be considered separately—

(1). *Hemimetabola and Holometabola*. As is well known, the first winged insects were all Hemimetabolous, i.e., they did not possess a true pupal or resting stage. In the Upper Carboniferous, where the Insecta are first met with in the fossil state, the percentage of Hemimetabolous insects is 100.0, that of Holometabolous insects 0.0. The same holds good, apparently, for the Lower Permian of Europe. In studying some two thousand specimens recently sent to me from Yale University, taken from the Lower Permian of Kansas, I am able to recognise the oldest known Holometabolous insects in the form of some very small wings undoubtedly belonging to the Order Mecoptera, the percentage of these wings to the total is under 1 per cent. The first record that we have of the Holometabola being at all abundant is in the Upper Permian Beds of Belmont, N.S.W., where no less than ten out of the nineteen known species are Holometabolous, or 52.6 per cent. No doubt this percentage will be considerably altered when a larger number of wings have been taken from these beds, but the important point to be noted is that here, for the first time, we find the Holometabola firmly established, and approximately 50 per cent. of the total fauna.

As we pass upwards through the various epochs to the present time, the percentage of Holometabola steadily increases, while that of the Hemimetabola just as steadily diminishes. In the European Lias, 58.7 of the fossils are Holometabola, only 41.3 Hemimetabola. For the whole of the Tertiary Insect Beds, the percentage of Holometabola is 80.0, that of the Hemimetabola 20.0. For Recent Pterygote Insects the percentage of Holometabola is 87.8, that of Hemimetabola 12.2. Thus we see that the older (Hemimetabolous) groups have steadily lost ground, while the newer (Holometabolous) groups have just as steadily gained.

Applying this result to the Ipswich fauna, we find that the percentages of Holometabola and Hemimetabola there lie *between* those of Belmont on the one hand and the European Lias on the other, but proportionately closer to the Lias than to the Belmont horizon, in the ratio of almost exactly two to one. Thus the Ipswich Beds fall, on this percentage, within the Upper Trias. If we take into account the probability that, even at this early date, some archaic groups (e.g., Aeroplanoptera and Protorthoptera) had found refuge in Australia, but were extinct in Europe, we should expect that a slightly increased percentage of Hemimetabola might be looked for in an Australian fossil bed as compared with a European fossil bed of the same age. If it is permissible to make a small allowance for this, we should then have to bring the horizon of the Ipswich Beds slightly nearer still to the Lias, i.e., to the top of the Upper Trias.

(2) *Blattoidea*. The Cockroaches are the most ancient of existing insects, and were present in great numbers in the Upper Carboniferous. In some Upper Carboniferous Beds (e.g., those of England and Germany) they are so abundant as to account for more than 90 per cent of the total insect fauna, but this, as Pruvost has pointed out, is only where the fossilised fauna was one inhabiting a locality exceptionally suitable for the existence of these insects. In other localities, as at Commeny and Mazon Creek, the percentage is much less (20 per cent. or lower), but still very considerable. In the Lower Permian we find the same thing, in some beds Cockroaches make up the majority of the fauna; in others, the percentage is much smaller. Not long after the disappearance of the Coal-measure forests, the Cockroaches began to die out very rapidly, and from the beginning of the Mesozoic to the present day they have been a decreasing group, their percentage to the total being 0.7 in the Tertiary, and only 0.4 in Recent times.

No cockroaches were present, as far as known, in the Belmont Beds, and we can only assume that the group had not been dispersed far enough to have reached Australia in Upper Permian times. Cockroaches are, however, present at Ipswich, and belong almost exclusively to that group, viz., the family Mesoblattinidae, which is typical of the European Lias. The exception to this is the single genus *Austromylacrites*, which is a remnant of an old Carboniferous group, quite extinct in the European Lias. If, then, we compare the Cockroaches of the Ipswich Beds with those of the European Lias, we find that the former has distinctly the higher percentage, 8.2, as against 7.4 for the Lias, and that it is morphologically slightly more archaic. Thus we can only conclude that, judged by the Cockroaches, the Ipswich Beds are somewhat older than the Lias, and are rightly considered as Upper Triassic.

(3). *Odonata*. The true Dragonflies or Odonata first arose in the Lower Permian, where a single species has recently been discovered by me from the Kansas Beds. Apart from Ipswich, no other records of the Order are to be found until we come to the European Lias, where they are represented by a number of

interesting genera, forming a considerable percentage of the total insect fauna. (Note —The percentage given in the Table does not include a number of new species recently described by me, but not yet published) These forms include no true Anisoptera, but only Zygoptera and an intermediate Suborder Anisozygoptera, from which the true Anisoptera arose at the beginning of the Upper Jurassic. The Odonata as a whole reached their maximum percentage in the Upper Jurassic, and from then onwards they declined rapidly. Their percentage in the Tertiary was 1.6, in Recent times only 0.6.

Comparing the Odonata of the Ipswich Beds with those of the Liassic, we note that the percentage is distinctly less for Ipswich, viz., 3.3, as against 5.2 for the Liass (the latter will be greatly increased when the new species are taken into account). Not only so, but the forms discovered at Ipswich, though closely allied to some of the Liassic forms, are distinctly simpler in structure, and therefore more archaic. The genus *Triassolestes* from Ipswich has a petiolate wing-base without any signs of an anal area at all, and is the only known Odonate type, exclusive of the undescribed Lower Permian form, which possesses thus exceedingly simple and archaic condition. As the evolution of the Order as a whole from exceedingly simple, petiolate types, of which our Australian genera *Hemiphysbia*, *Chorismagrion* and *Synlestes* are the nearest existing forms at the present day, has been clearly established, not only by the discovery in the Lower Permian of Kansas, but also by Dr C. H. Kennedy's wonderful work on the penes of the males of Odonata, we may safely conclude that the Ipswich Odonate fauna belongs to a period not far from the Liass, but undoubtedly somewhat older. This evidence, then, would also point to an Upper Triassic age for the Ipswich Beds.

(4) *Evolution of the Trichoptera and Diptera.* In the Upper Permian of Belmont there occur two remarkable wings, *Belmontia** and *Parabelmontia*,† which I have shown to be allied to the true Mecoptera and almost certainly a portion of the original stock which gave origin to the three Orders Diptera, Trichoptera and Lepidoptera. *Belmontia*, which possesses the distal fork of Cu₁, indicates the condition of evolution at that time of the combined Trichoptero-Lepidopterous ancestral stock. *Parabelmontia*, which has a simple Cu₁, indicates the condition of the ancestors of the Diptera at that time. In the European Liass, no wings comparable to these two are to be found, but true Trichoptera appear in the Lower Liass, and true Diptera in the Upper Liass. Now if we turn to the Ipswich fauna, we find, on the one hand, no true Paramecoptera present, and on the other hand no true Trichoptera or Diptera present either. But there is present a group, which I have placed in a separate Order Paratrachoptera, in which the wings closely resemble those of archaic Trichoptera and Diptera, but differ from both of them in important points. They are not true Trichoptera, because they do not possess the apical fork of Cu₁, which all archaic Trichoptera possess. They are not true Diptera, because they have not yet undergone any reduction or narrowing-in of the basal part of the wing, and, therefore, by inference, they also still possessed well developed hindwings. These wings of the Order Paratrachoptera are, in fact, intermediate forms between the Upper Permian *Parabelmontia* and true Diptera. Hence we must conclude that the beds in which they are found lie between the Upper Liass, where true Diptera occur, and the Upper Permian, where *Parabelmontia* occurs. Also, since no true Trichoptera occur at Ipswich,

* These Proceedings xlv., 1919, p. 234.

† These Proceedings, xlvii., 1922, p. 284.

and such were fairly abundant in the Lower Liass, it is a fair conclusion to come to that these beds are not Lower Liass, but somewhat older. The same result is obtained if we consider the time it would take, in the course of evolution, for the Paratrachoptera to lose their hindwings and become true Diptera. If these wings were Lower Liassic, we should at any rate expect to see some more definite evidence of reduction of the base of the forewing, indicating the actual beginnings of the true Order Diptera. Morphologically, the wings of the Paratrachoptera are almost as close to those of *Parabelmontia* as they are to the forewings of Diptera, and this fact requires that we should place them at least as far back as the Upper Trias.

(5). *Coleoptera*. The first known fossil Coleoptera are a few small elytra recently found at Belmont, but not yet described. These elytra are closely similar to the majority of the elytra found at Ipswich, and can be definitely assigned to the Hydrophilidae. The percentage of Coleoptera in the Liass was just about 42, and this Order, the dominant one amongst the Insecta, has kept this percentage almost unchanged to the present day. At Ipswich, the percentage was 47.6. A simple explanation of this record percentage is to be found if we look at the percentages of the other Holometabolous Orders at Ipswich. No Diptera or Trichoptera had yet appeared on the scene, and the Mecoptera and Planipennia were not yet as abundant as they were in the Liass. It has been the uprising of these groups and, later on, of the Hymenoptera and Lepidoptera, which has kept the percentage of Coleoptera stationary, in spite of the great actual numerical increase of species within the Order. Hence we find, at Ipswich, a period represented when the Coleoptera, as the first of the highly successful Holometabolous Orders (for the older Mecoptera and Planipennia never became highly successful), reached its maximum percentage compared with other Orders. Such a period must of necessity have been somewhat earlier than the Liass, while the great disparity between the percentages of Coleoptera at Belmont (10.5 per cent) and Ipswich (47.6 per cent) would indicate that it was considerably removed from the Upper Permian. The evidence, then, would lead us to assign an Upper Triassic age for the Ipswich Beds.

(6) *Hemiptera*. This Order offers very convincing evidence of the age of the Ipswich Beds. Hemiptera first appear in the Upper Permian, both in Europe and at Belmont, and are in both cases represented by only the single Suborder Homoptera. The Order was at its maximum percentage at Belmont, chiefly because no other groups were present in sufficient numbers to compete with it, except only the Mecoptera. From that time onwards its comparative percentage decreased to the end of the Mesozoic, rising again to 12.3 in the Tertiary, and finally falling to 7.9 at the present day. At the same time, the Suborder Heteroptera, which was absent in the Upper Permian, has gradually gained on the Suborder Homoptera, until at the present day it accounts for 4.5 of the 7.9 per cent. for the whole Order, leaving only 3.4 for the Suborder Homoptera. In the European Liass, the percentage of Hemiptera to the whole Insect fauna is 9.6, made up of 7.4 Homoptera and 2.2 Heteroptera. Thus it will be seen that, in the Liass, the Homoptera were more abundant than the Heteroptera in the proportion of about 7 to 2, though at the present day the Heteroptera are the more abundant. At Ipswich, the percentage of Hemiptera to the total Insect fauna is 27.9, which is intermediate between the percentage for Belmont (47.4) and that for the European Liass (9.6), and somewhat nearer the latter than the former. Also, if we compare the proportions of Homoptera to Heteroptera, we find 22.2 per cent of the former to 5.7 per cent. of the latter, or a proportion of about 4 to 1, i.e., the

Homoptera are a little more abundant proportionately than in the Lias. Expressed as percentages of the whole Order Hemiptera, we have the following results —

Suborder	Belmont	Ipswich	European Lias	Recent
Homoptera	100 0	79 6	77 1	43 0
Heteroptera	0 0	20 4	22 9	57 0

We see again from this result that the evidence offered by the percentage and composition of the Order Hemiptera at Ipswich is to the effect that the age of the Ipswich Beds is intermediate between the Upper Permian of Belmont and the European Lias, and definitely closer to the latter than to the former.

On all the above six counts, then, we come to the same conclusion, viz, that the Ipswich Beds are definitely older than the Lias, but not very much older. The same results would have been obtained if we had considered the whole of the Order Orthoptera, since we should then note, not only the relative decrease in the Cockroaches as we pass from Ipswich to the Lias, but also the relative increases in the two newer Suborders Mantodea and Locustodea. As the first known Locustoid occurs in the passage beds between Upper Permian and Lower Trias in the Balmain Colliery at Sydney, N S W,* the relative increase of the Suborder Locustodea is particularly striking, this Suborder is outstandingly the dominant group of Orthoptera at the present day.

The presence at Ipswich of archaic Orders (Aeroplanoptera, Protorthoptera, Protomecoptera) not found in the Lias or any later beds, also leads us to the same conclusion.

Making all due allowance for the possibility of an Australian Mesozoic Insect fauna being somewhat more archaic in composition than a European fauna of the same time (but not much, for it is clear that the Upper Permian Insect fauna of Belmont was, if anything, ahead of contemporary faunas in other parts of the world), the following would appear to be a fair conclusion as to the age of the Ipswich Insect Beds —

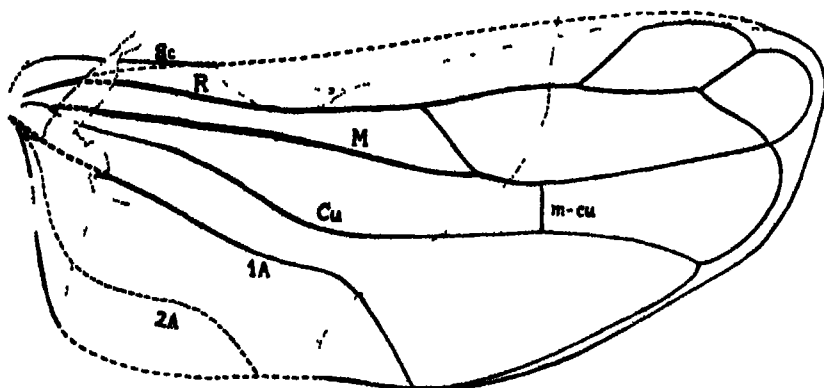
The composition of the Insect Fauna of the Ipswich Beds indicates, both collectively and by analysis of its outstanding groups, that *the age of the Beds was not earlier than the lowest division of the Upper Triassic, and not later than the top of the Upper Triassic, it was most probably a little older than Rhaetic*

* *Elcanopsis sydneyensis* Till, These Proceedings, xliii, 1918, p 263

Appendix

Order **HEMIPTERA**.Suborder **Hemiptera**.Family **IPSVICIIDAE***IPSVICIA JONESI* Till (Plate xliii, fig 38; Text-fig 90)

Hindwing Total length 10.5 mm, greatest breadth 4.7 mm. A nearly complete impression, with most of the costal margin and about one-third of the posterior margin missing. Main veins stoutly built. R slightly waved, giving off at about half-way a descending oblique branch which meets M somewhat before the level of the medio-cubital cross-vein, further distad, R gives off an anterior oblique branch, and finally forks widely not far from apex, the ambient vein connects these last three branches of R in two loops, and continues posteriorly as a convex loop between the ends of M and Cu, and as a slightly convex loop between Cu and 1A, the ambient vein is throughout very close to the wing-margin. M nearly straight up to half-way, and then curving slightly upwards to meet the posterior distal fork of R at its apex. Medio-cubital cross-vein (m-cu) situated at about two-thirds. Cu considerably waved near middle concavely to costal border, unbranched. 1A a strong, simple vein strongly bent downwards in its distal third. 2A a shorter vein, strongly double-curved.



Text-fig 90 *Ipsvicia jonesi* Till Hindwing (x 67) Missing portions restored by dotted lines. Drawing made from Specimens No 285a and 340. 1A, 2A, first and second anal veins. Cu, cubitus, M, media. m-cu, medio-cubital cross-vein, R, radius, Sc, subcosta.

Heautotypes. Specimen No 285a shows the hindwing as figured in Plate xliii., fig 38 and Text-fig 90, the whole of 2A as well as the dotted portions of the costal and posterior margins are missing in this specimen. Specimen No 340a is an impression of all four wings of a large individual close together and partially overlying one another. A large portion of the base of one hindwing, lying clear of the tegmina, shows 2A and 1A complete, a considerable portion of M, and about the basal fourth of R and the costa, Sc can be seen as a short vein joining the costa not far from base. One tegmen is complete, measuring 18 mm long; the other has only the apical portion preserved, and the second hindwing is folded under and between the two, so that only a small part of it can be seen.

This specimen affords the proof that the more complete hindwing represented by itself in Specimen No 285 belongs to *Ipsivicia jonesi* Till

Additional material of the tegmina of this species is found in Specimen No 226, consisting of a complete tegmen, 13 mm long, only moderately well preserved, together with a small fragment of the base of a second tegmen lying close beside it, 17 mm away from these, on the same piece of rock, lies another almost complete tegmen, moderately well preserved. All the above are in Coll Queensland Geol Survey, Brisbane, Q

Horizon — Upper Triassic, Ipswich, Q

The discovery of the hindwing of the genus *Ipsivicia* is of great interest, because of the simplicity of the venation, in which M is unbranched, and the primitive condition of the ambient vein, lying very close to the border of the wing. These characters can now be added to the definition of the family Ipsivicidae, which would appear to be well established on the combined characters of the tegmen and hindwing.

Suborder **Heteroptera.**

Family TRIASSOCORIDAE

TRIASSOCORIS MYERSI Tillyard

Specimen No 150a-b appears to represent the body of this species, with the exception of the head and pronotum, which are missing. The scutellum is broad and triangular, the shape of the body broadly oval. There are signs of the segmentation of the first two abdominal segments only. *Total length* of specimen, 5.1 mm, *greatest breadth* 4.4 mm.

TRIASSOCORIS SCUTTULUM Tillyard

Specimen No 179a-b appears to represent the body of this species, with the exception of the head and pronotum, which are missing. The scutellum is subtriangular, less wide than in *T. myersi*, the shape of the abdomen is somewhat narrower, and somewhat pointed apically. *Total length* of specimen, 5 mm, *greatest breadth* 3 mm.

TRIASSOCORIS OVALIS, n sp (Text-fig 91)

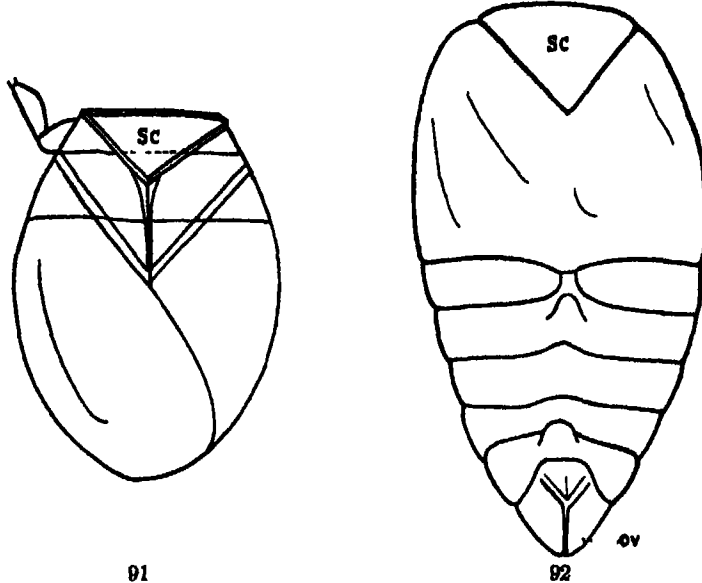
This is also an impression of the whole body with the exception of head and pronotum, in addition, the hemelytra can be faintly made out. The scutellum is triangular, not so wide as in *T. myersi*, the abdomen is broadly oval, even more rounded apically than in *T. myersi*, the hemelytra appear to be slightly granulose and also slightly and deately striated distally. There is also what appears to be an impression of portion of the left fore-leg. *Total length* of specimen, 4.8 mm, *greatest breadth* 3.6 mm.

Type, Specimen No. 129a, in Coll Queensland Geol Survey, Brisbane.

Horizon — Upper Triassic, Ipswich, Q

TRIASSOCORIS GRANDIS, n sp (Text-fig 92)

This specimen shows the same parts of the body as the three preceding, but is considerably larger, it is remarkable in that the wings were either missing or too faintly impressed to be made out with certainty, whereas on the other hand the segmentation of the abdomen is clearly marked, so that it can be seen that the



Text-fig 91 *Triassocoris ovalis*, n sp Body with hemelytra and part of left foreleg. (x 67) Drawn from Specimen No 129a sc, scutellum

Text-fig 92 *Triassocoris (?) grandis*, n sp Body (x 67) Drawn from Specimen No 196a ov, ovipositor, sc, scutellum

specimen was a female The scutellum is sub-triangular, rather small for the size of the insect, and comparatively narrow In the abdomen, which is sub-triangular and well pointed apically, six segments can be clearly made out, together with a terminal ovipositor Total length of specimen 7.3 mm, greatest breadth 3.9 mm

Type, Specimen No. 196a in Coll. Queensland Geol Survey
Horizon—Upper Triassic, Ipswich, Q

Order NEUROPTERA.**Suborder Planipennia.****Family PROHEMEROBIIDAE**

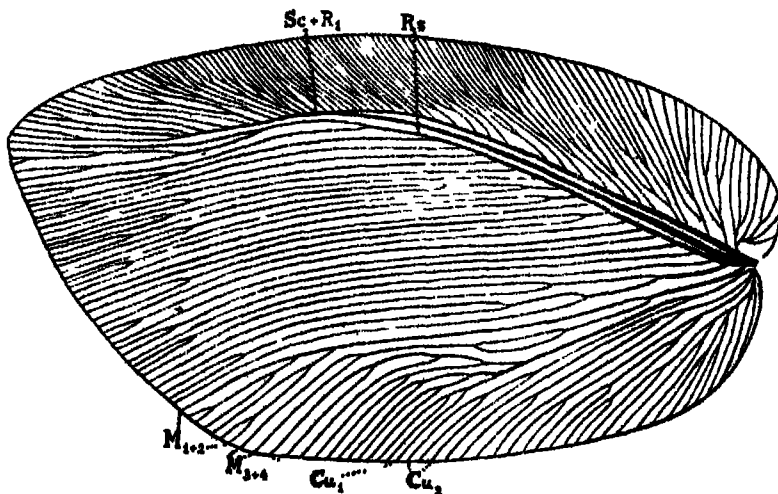
This family is characterised by a general similarity to the recent Psychopidae, but is less specialised in lacking the strong *vena triplex* formation found in that family, and in having the wings less rounded apically, with the costal space not so broadly expanded. A single genus and species, *Protopsychope venosa* Till., has already been described from Ipswich

Genus *OSMYLOPSYCHOPS*, n.g. (Plate xliii, figs 39, 40, Text-fig 93).

Costal area of moderate breadth basally, diminishing towards apex. Costal veinlets arising from Sc close to base at an angle of about 45° , but this angle rapidly diminishes further from the base, and for most of the wing-length is about 25° to 20° , these veinlets very numerous and close together, many of them forked, but there are no clear signs of any connecting cross-bars. Sc straight for most of its length, then arching somewhat downwards and fusing at a slight angle with R_1 (as in recent *Osmylidae*). R_1 a strong vein, straight for most of its length, but somewhat curved downwards after fusing with Sc. R_s running close below R_1 , but neither fused nor connected with it in any manner. Branches of R_s numerous, about twenty, closely parallel, some forked near bases, most of them with small distal forks. These sectors arise from R_s at an angle varying from 35° to 30° only. M forked near base, the two branches running closely parallel to one another and to the branches of R_s just above them. Cu forked near base. Cu_2 running close below Cu_1 for most of its length, some little way from the posterior border of the wing, Cu_1 arches away from Cu_2 and branches into several forked veins which occupy the triangular space between M_3+4 and Cu_2 . Anal veins with numerous branches.

Genotype, *Osmylopsychops spillerae*, n.sp. (Upper Trias of Ipswich, Q.)

This genus is undoubtedly a true Probemerobid on account of the general structure of the venation and the primitive condition of the three veins Sc, R_1 and R_s , which do not form a true *vena triplex*, but it is remarkable in having Sc fused with R_1 in the manner of recent *Osmylidae*. This character is indicated in the generic name. The distal branching of Cu_1 is also peculiar and indicates, perhaps, some connection with the Berothidae. The small angle at which the branches of R_s arise is also noteworthy, and will serve to distinguish this genus at a glance from the other Triassic Planipennia.



Text-fig 93 *Osmylopsychops spillerae*, n.g. et sp. Restoration of forewing ($\times 25$). Cu_1 , Cu_2 , first and second branches of cubitus. M_1+2 , M_3+4 branches of media; R_s , radial sector, $Sc+R_1$, fused subcosta and radius.

OSMYLOPSYCHOPS SPILLERAE, n.sp. (Plate xlii, figs 39, 40; Text-fig 93)

This species is represented by two fairly large wing-fragments, both probably belong to the forewing, but not to the same individual.

Specimen No 314a has a total length of 14 mm, and shows most of the basal portion (the costal and posterior margins indistinct), with a distance of about 5 mm along the three main veins Sc, R₁ and R_s. Beyond this there is a gap, but, below that gap, a series of no less than thirteen sectors of R_s are preserved completely to the somewhat broken wing-margin, below these again are the complete M and Cu and basally, all except the extreme bases of the anal veins are preserved. A noteworthy feature of M₃₊₄ is the presence of an elongate oval closed cell about the middle of its length, this cell indicates the division and re-fusion of M₃ and M₄, and is to be found in a number of recent Psychopidae. It is most probably a specific character, but may have been only an individual one. The apical expansion and forkings of Cu₁ are well shown in this specimen.

Specimen No 283a has a length of 12.5 mm and shows a large portion of the wing with the exception of the basal third, the extreme apical piece, and the margins of the wing, there is also a large gap in the distal portions of a number of the branches of R_s. The distal forkings of Cu₁, and the course of Cu₂ in a deep furrow just below it, are absent except for a small portion, but this portion is just sufficient to allow of this fragment being placed in position upon the previous fragment, when it will be seen that the two practically coincide with respect to every vein common to the two, so that they evidently belong to the same species. This fragment shows very clearly the fusion of Sc with R₁, and the manner in which R_s remains unconnected with R₁ throughout, though running closely below it.

Type, Specimens No 314a (holotype) and No 283a (lectotype) in Coll. Queensland Geol. Survey, Brisbane.

Horizon—Upper Triassic of Ipswich, Q.

The species is dedicated to Miss S. M. Spiller, of the Geological Survey, Brisbane. The complete forewing is shown restored in Text-fig. 93.

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- DUNSTAN, B., 1916—Mesozoic and Tertiary Insects of Queensland and New South Wales. Stratigraphical Features. *Qland Geol. Survey*, Publ. No 253, pp 1-10.
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- , 1918a—Permian and Triassic Insects from New South Wales, in the Collection of Mr. John Mitchell. *Id.*, xlii, pt 4, pp 720-756.

- - - , 1918b Mesozoic Insects of Queensland No 3 Odonata and Protodonata *Id*, xliii pt 3, pp 417-436
- , 1918c ----- No 4 Hemiptera Heteroptera the Family Dunstanidae With a Note on the Origin of the Heteroptera *Id*, xliii, pt 3, pp 588-592
- , 1919a ----- No 5 Mecoptera, the new Order Paratrichoptera, and additions to Planipennia *Id*, xlii, pt 1, pp 194-212
- - - - - , 1919b ----- No 6 Blattoidea *Id*, xlii, pt 2, pp 358-382
- - - - - , 1920 ----- No 7 Hemiptera Homoptera, with a Note on the Phylogeny of the Suborder *Id*, xlii, pt 4, (1920), pp 857-896
- - - - - , 1921 ----- No 8 Hemiptera Homoptera (contd) The Genus *Mesogereon*, with a Discussion of its Relationship with the Jurassic Palaeontinidae *Id* xlii, pt 2, pp 270-284
- - - - - , 1922—Mesozoic Insects of Queensland No 9 Orthoptera, and Additions to the Protorthoptera, Odonata, Hemiptera and Planipennia *Id*, xlii, pt 4 pp 447-470

EXPLANATION OF PLATE XLIII

- fig 38 *Ipswichia jonesi* Till Hindwing (x 61) Specimen No 285a
- fig 39 *Osmolyopsychops spilleriae*, n g et sp Fragment of wing (x 56) Specimen No 314a Holotype
- fig 40 *Osmolyopsychops spilleriae*, n g et sp (x 6) Specimen No 283a Neautotype

Corrigendum

On page 482 insert the heading, *Sub-order Zygoptera*, above Family Triassolestidae (line 12)

THE LIFE-HISTORY OF *PHEROSPHAERA*

By A. ANSTRUTHER LAWSON, D.Sc., F.R.S.E., F.L.S., Professor of Botany in the University of Sydney

(Plate xlv, thirty-one Text-figures)

(From the Botany Department of the University of Sydney)

[Read 31st October 1923]

The genus *Pherosphaera* was established by Archer (1850). There are but two species known, one found in certain mountainous regions of Tasmania and the other confined to certain limited regions of the mainland of Australia.

Pherosphaera is a small, low shrub, the two species having different habitats and somewhat different habits. *Pherosphaera Fitzgeraldi* F.v.M. is a densely branched semi-prostrate shrub and is found within the spray of certain waterfalls in the Blue Mountains of New South Wales. *Pherosphaera Hookeriana* Arch. is a densely branched erect shrub from three to six feet high inhabiting certain mountain regions of Tasmania. It is found in wet soil. Photographs of *P. Fitzgeraldi* F.v.M. are shown on Plate xlv.

The foliage of the two species is very similar, consisting of small thick scale-like leaves about half a line long. They are keeled, obtuse and closely appressed and appear in rows. A dark olive-green colour is characteristic.

The organs of fructification are also similar in the two species. The microspore cones are solitary and terminal. They occur in profusion, but singly. They are oval in form, about one and a half lines long, and composed of several spirally arranged microsporophylls.

The megaspore cones are laterally arranged on small branches. These are ovate and consist of eight or ten spirally arranged megasporophylls, each one of which has a solitary, erect ovule on its adaxial face very close to the cone axis.

This unique genus of Conifers has for many years been classed among the Podocarpaceae, although it possesses no outstanding features justifying this position. Moreover, as far as the writer is aware, we have no knowledge whatever of its gametophyte structures.

For these reasons it seemed desirable to work through the life-history and establish its phylogenetic position.

The inaccessible nature of the material has made the task a difficult one, but during the past three or four years sufficient material has been obtained to show all the essential features of the gametophytes, fertilisation and embryo.

The Male Gametophyte

The first and most striking feature of the pollen of *Pherosphaera* is its minute size as compared with the pollen of other Conifers,—especially the Podocarpaceae. It is about half the size of that of *Microcachrys* for instance. The microspore

wall is very thin and as in *Microcachrys* and other Podocarpaceae it is winged. The wings take the form of three bladder-like dilatations of the spore wall. These wings are arranged precisely as they are in *Microcachrys*, only they are smaller in proportion to the size of the spore. After a careful study of many preparations, both from the living condition and from sections, I am convinced that only three wings are present. In sections, the majority of cases showed only two wings as illustrated in Text-figures 2 and 3, but there is no doubt in my mind that the third was removed in sectioning. Text-figure 1 shows the typical more or less symmetrical arrangement of these wings. My observations of these external features of the microspore agreed for both species of *Pherosphaera*.

The surprising and important feature of the microspore was observed in regard to its contents. When the mature pollen was first examined in the living state two distinct nuclei were clearly visible, but no trace of vegetative prothallial cells could be made out. It was expected, however, that these latter would be detected in sections as they are so characteristic in *Microcachrys* and other Podocarpaceae. In the many preparations examined, however, not a single section showed any evidence of these vestigial cells. Two nuclei were all that were observed in the mature pollen. Text-figure 2 shows a typical section of a mature microspore at the time of pollination. One of these nuclei is slightly more centrally situated than the other and in one or two instances there was a slight indication of a delicate membrane separating them from one another, but in the majority of those brought under observation all trace of a separating wall was absent. Text-figure 2 was drawn from a section of a microspore within the microsporangium at the time the pollen was being liberated. Text-figure 3 was drawn from a section of a microspore within the micropyle. It will be seen that no wall separates the nuclei, and a slight protuberance at one side indicates the beginning of the pollen tube.

In view of our knowledge of the male gametophyte of the Podocarpaceae, and especially in view of the winged nature of the pollen, these observations were quite unexpected. *Pherosphaera* is the only genus of this tribe where male gametophytes have not been investigated. In all of the other five genera of the tribe a more or less evanescent prothallial tissue is present in the mature pollen. In *Podocarpus* (Coker, 1902) there are at first the usual two prothallial cells, but as the pollen matures these two cells undergo further divisions until, in certain cases, there may be as many as eight prothallial cells. The walls of these cells eventually break down and the resulting free nuclei pass into the pollen tube. So the mature pollen of *Podocarpus*—in certain species at any rate—may contain in addition to the tube and stalk nuclei and body cell, no less than eight vestigial prothallial cells.

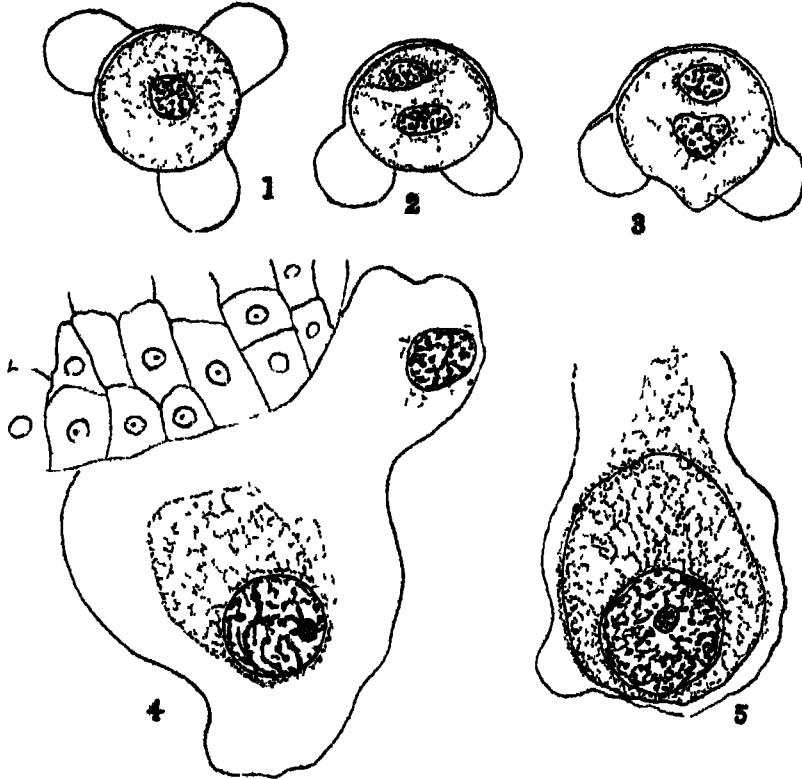
In *Phyllocladus* (Kildahl, 1908 and Young, 1910) the condition is somewhat different. Here we find two prothallial cells, one of which almost immediately becomes disorganized but the second one persists and may divide. In this genus the mature microspore therefore contains four free nuclei and a body cell.

In *Dacrydium* (Young, 1907) the mature microspore may contain three or four vestigial prothallial nuclei in addition to the tube and stalk nuclei and body cell.

In the mature microspores of *Microcachrys* (Lawson, 1923; Thomson 1909a) there are two vestigial prothallial cells which persist and do not divide, in addition to the body cell and stalk and tube nuclei.

Saxegothaea shows within its mature microspore, three vestigial prothallial nuclei as well as the body cell and stalk and tube nuclei.

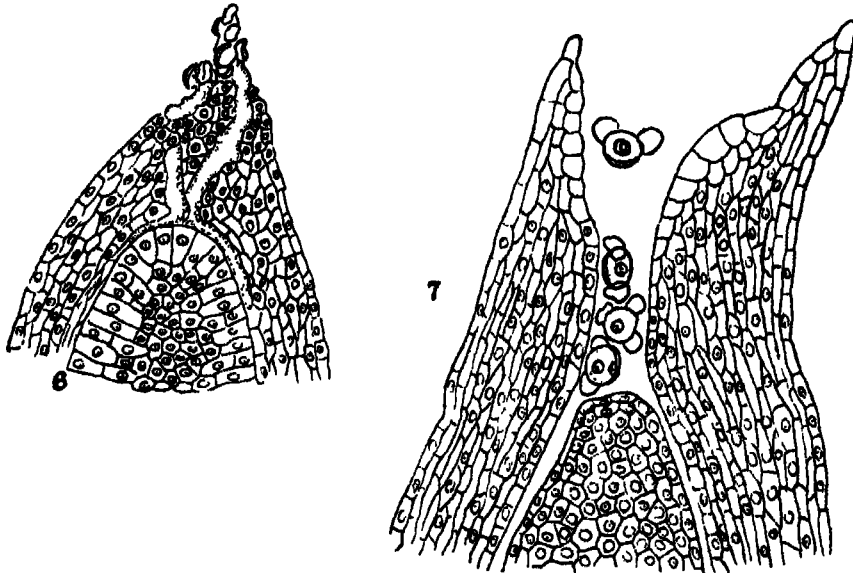
In view of these observations it would seem that supernumerary cells or nuclei derived from one or both of the prothallial cells are a common characteristic of these five genera of the Podocarpaceae. In *Pterosphaera*, however, the contents of the mature microspore seem to be quite different. As far as my observations go there are only two free nuclei in the mature microspore. One of these



- Text-fig. 1 A section of a microspore through a plane showing three wings. These wings are dilations of the spore wall and are symmetrically arranged. A single nucleus is seen suspended in the centre of the spore cytoplasm. (x 667).
- Text-fig. 2 A section of a microspore showing two nuclei, one nearer the centre of the spore than the other. Two of the wings are shown in this section. (x 667).
- Text-fig. 3 A section of a microspore as it was seen in the macropyle. Only two of the three wings are shown in the section. Two nuclei of about equal size lie in the cytoplasm. A slight protuberance of the spore wall between two of the wings indicates the beginning of the pollen tube. (x 667).
- Text-fig. 4 A longitudinal section through the tip of a nearly mature pollen tube. A large body cell with its enlarged nucleus in the apical stage of mitosis, and its characteristic cytoplasm is shown. The body cell has a very thin but distinct cell membrane. In the rear of the body cell is the stalk nucleus. (x 667).
- Text-fig. 5 A similar section of the tip of the pollen tube showing the characteristic appearance of the body cell whose nucleus is preparing for mitosis to form the gametes. (x 667).

is interpreted to be the tube nucleus and the other the generative nucleus. No trace of vestigial prothallial cells or nuclei was observed.

The only resemblance, therefore, existing between microspores of *Pherosphaera* and other genera of the Podocarpaceae are the wings. This character, however, is not confined to the Podocarpaceae, it being one of the characteristic features of the Abietineae. Moreover, in one genus of the former tribe—namely *Saxegothusa* (Thomson, 1909), the pollen is not winged. Winged pollen seems to have arisen in more than one tribe of Conifers quite independently as a special adaptation in pollination and it would be unwise, therefore to regard it as a character of important phylogenetic significance.

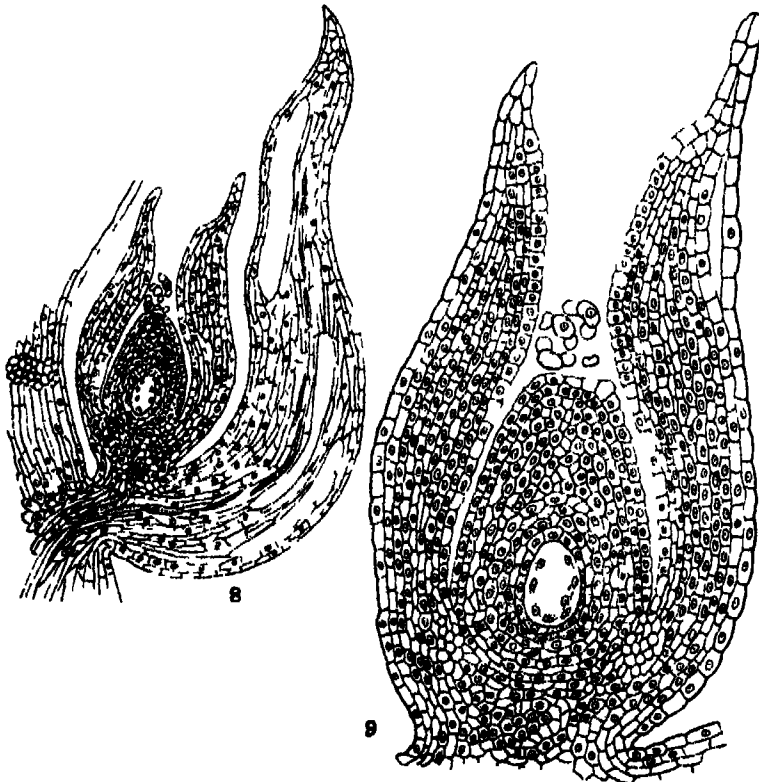


Text-fig 6 A longitudinal section through the upper part of the nucellus. The cells of the apex form a more or less definite pollen cushion. Three winged microspores are shown at the very apex, and each of these has sent down pollen tubes whose tips spread out over the apex of the prothallus.

Text-fig 7 A longitudinal section of a micropyle with the apex of the nucellus. Four microspores are distinctly seen in the micropylar canal and these show the characteristic wings, and one of them shows the two nuclei. The characteristic spreading of the integument for the reception of the pollen is also indicated. (x 133)

The device for the reception of pollen in *Pherosphaera* is quite simple and interesting. The megasporophyll grows out for a short distance almost at right angles to the cone axis. It then turns sharply in a vertical direction almost parallel to the cone axis. The apex tapers to a point and curves slightly outward. There is thus left a considerable opening between it and the bract above. In the meantime the integument of the ovule has grown forward in a direction almost parallel with that of the sporophyll. The combination of the end of the sporophyll and the gaping apex of the integument forms a deep cavity which is wide at the top and narrow at the bottom like a funnel, the micropyle forming the neck of the funnel-shaped cavity. When once caught by the mouth of this

opening the pollen grains must eventually find themselves in the micropyle. Text-figure 8 represents a median section through the sporophyll bearing an ovule. Here this gentle curvature leading into the micropyle is clearly shown. A few pollen grains have already found their way into the micropyle. In Text-figure 7, we have a more highly magnified representation of a longitudinal section taken through the upper portion of the nucellus and integument. Here four micro-



Text-fig 8 A median longitudinal section through a megasporophyll just about the time of pollination. The position of the megasporangium is clearly shown. Its close proximity to the cone axis is characteristic. The gaping mouth of the integument for the reception of the pollen in the short tube-like micropyle is also indicated. (x 50)

Text-fig 9 The ovule in Text-fig 8 more highly magnified. Three microspores are seen in the micropyle. A germinated megaspore is shown in the basal region of the nucellus with a tapetum still enveloping it. The megaspore has undergone repeated free nuclear division, and there is a large central vacuole. (x 100)

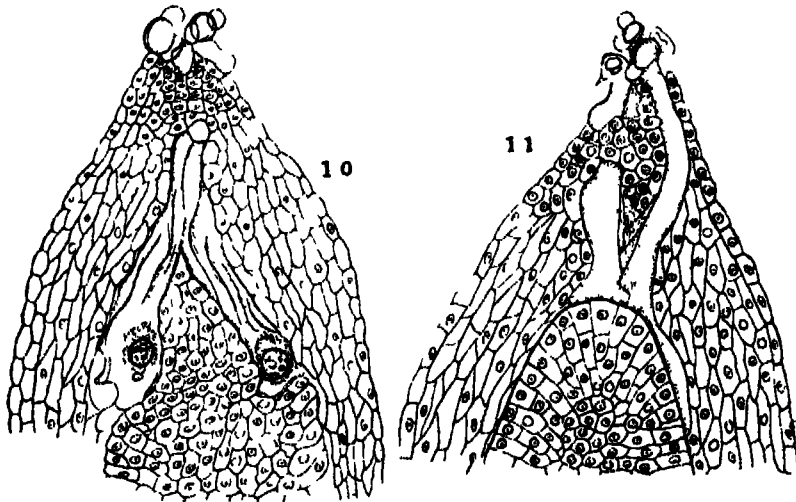
spores are seen in their descent through the micropyle. The wide open mouth of the funnel-shaped micropyle is clearly shown and the cells lining this inner region of the integument are enlarging considerably in preparation for the closing of the micropyle. These details are shown also in Text-figure 9, but here the microspores have reached the apex of the nucellus.

Having reached the apex of the nucellus, each microspore produces a pollen tube which immediately penetrates the nucellar tissue, carrying with it the tube

and generative nuclei. As shown in Text-figures 10 and 11 the winged walls of the microspores are left behind on the apex of the nucellus. The pollen tubes in the meantime have penetrated the entire length of the nucellus. The course of the tubes was followed in several instances. They reach the female prothallial tissue and apparently have their full growth before the archegonia are organised. In Text-figure 10 we have a not quite median section through the upper half of the ovule. Two pollen tubes are seen. They evidently followed a common course until the prothallial tissue was reached, then their ways separated— one growing to the right and the other to the left as they pass over the top of the female gametophyte.

In Text-figure 11, there is another illustration of a tube passing down for a considerable distance between the megaspore membrane and the nucellus. The great length to which the pollen tube may penetrate in this direction is shown in Text-figure 18. Here a pollen tube is seen extending nearly half-way down the length of the prothallus. The courses of these tubes are well established before the archegonia appear. In Text-figure 18 two young archegonia are shown. Other pollen tubes are illustrated in Text-figures 19 and 20.

The actual mitosis of the generative nucleus was not observed. It must



Text-fig 10 A nearly median section of the upper half of the ovule. Microspores with their pollen tubes are indicated. The latter have penetrated the entire length of the nucellar tissue and their tips with their contents have entered the cavities of the prothallus just over the archegonia. The archegonia themselves appeared in the following sections. In the tips of the pollen tubes the body cell with its deeply staining nucleus is clearly indicated. (x 275)

Text-fig 11 A more highly magnified representation. A condition similar to that indicated in Text-fig 8, showing in detail the course of the pollen tube through the nucellar tissue and nearly half-way down the length of the prothallus. (x 275)

occur, however, quite early in the development of the pollen tube, for frequent instances were found showing a well organised body cell and stalk nucleus in the tip of the tubes before the latter was half-way through the nucellar tissue. In Text-figure 10 two pollen tubes are represented, each with a well organised body cell. A characteristic appearance of a section of a tip of a pollen tube is shown

in Text-figure 4. The nucleus of the body cell does not lie in the centre of the cytoplasm, but is suspended at one side. In this figure it is evidently just about to undergo mitosis to form the gametes, as its chromatin is in the spireme stage. The body cell is surrounded by a thin but distinct membrane of its own. In the rear of the body cell the stalk nucleus is seen. Another example of the body cell showing these characteristics is shown in Text-figure 3. The actual division of the body cell was not observed and I am consequently unable to give an account of the gametes. On account of the small number of archegonia and their scattered position one would expect to find the two gametes of unequal size and only one functional as in *Podocarpus* (Coker, 1902) and *Phyllocladus* (Young, 1910).

The Ovulate Strobilus

The structure of the ovulate strobilus and the position of the ovule is strikingly unlike the type of the Podocarpaceae. Among the Taxaceae the ovulate strobilus is so much reduced that it is difficult to identify it as a cone. In some cases such as *Torreya* (Coulter and Land, 1905) and *Cephalotaxus* (Lawson, 1907 and Coker) the reduction is carried so far that all resemblance to a strobilus is lost.

Among the Podocarpaceae there appears to be a considerable variety in the amount of reduction in the different genera.

In *Microcachrys* there is a definite strobilus formed by sporophylls which have what appear to be a spiral arrangement, but this appearance is really due to the sporophylls being in cycles of four (Thomson, 1904, Lawson, 1923). There is a single more or less mounted ovule near the apex of the adaxial face of the ovuliferous scale.

In *Saxegothaea* the strobilus is made up of a series of unbracted bracts spirally arranged in the form of a cone. On the adaxial face of the ovuliferous scale a solitary ovule is borne. The strobilus is terminal on the short shoots (Tison, 1908). The peduncle eventually elongates, carrying the strobilus beyond the enveloping bracts.

In *Podocarpus* there is also a solitary ovule which extends conspicuously above the bracts, but this is not brought about by the elongation of the peduncle.

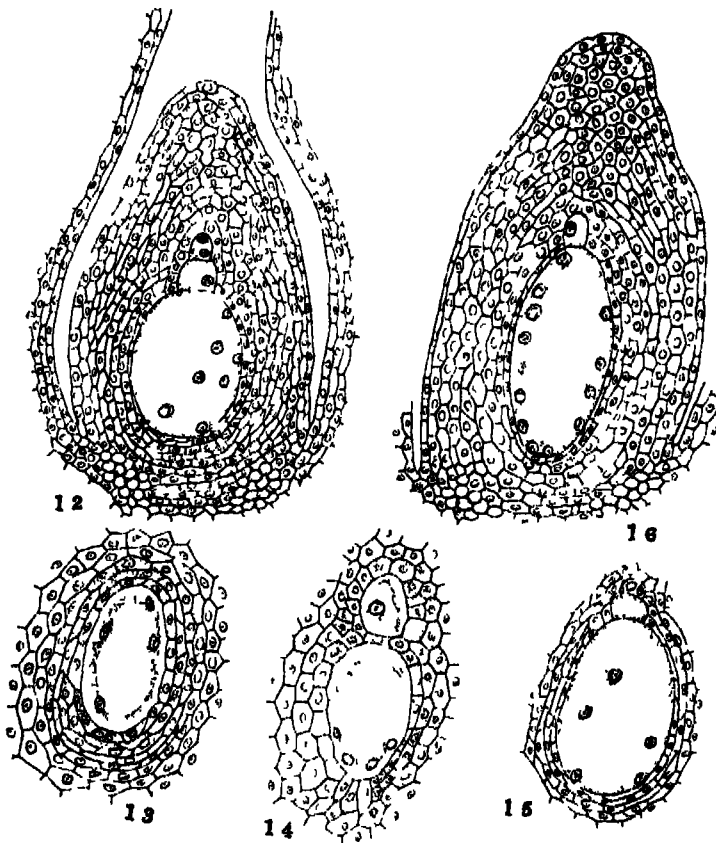
In *Phyllocladus* the ovulate strobili occur either singly or two together. They consist of six or eight short thick bracts and are borne near the base of the phylloclads. Each bract bears a solitary erect ovule.

In *Pherosphaera* a definite strobilus is formed by a series of sporophylls. On the adaxial face of the ovuliferous scale, very close to the cone axis and therefore in an axial position, a single erect ovule is borne.

The Megasporangium

The megasporangium of *Pherosphaera* presents certain features that distinguish it at once from other Podocarpaceae. Its position is practically axial, being close to the cone axis on the adaxial surface of the megasporophyll. It is, therefore, in this respect quite unlike *Podocarpus*, *Microcachrys* and *Saxegothaea*. In *Phyllocladus* the ovule is axillary. It is also erect and more or less invested as in the case with *Podocarpus*, *Microcachrys* and *Saxegothaea*.

In *Phyllocladus*, however, the solitary ovule is erect and axillary. A median longitudinal section of the sporophyll is shown in Text-figure 8. Here a portion of the cone axis is seen and the axillary position of the base of the ovule. The apex of the sporophyll is shown extending a considerable distance beyond the in-



- Text-fig 12 A longitudinal section through a young ovule. The general configuration of the nucellus is shown and in a nearly central position three megaspores are seen forming an axial row. All three of these megaspores have germinated and are multi-nucleate. The lower of the three is much the largest. The middle one is next in size and the distal one is smallest. (x 275)
- Text-fig 13 A longitudinal section through the centre of the megasporangium showing a germinated megaspore. Repeated free nuclear division has taken place, and the formation of a large central vacuole forces the nuclei to take a position in the parietal cytoplasm. A more or less definite tapetum of two or three layers of cells is also represented. (x 275)
- Text-fig 14 A similar section of the megasporangium showing two germinated megaspores. They are both enveloped in tapetal cells, but one is much larger than the other. (x 275)
- Text-fig 15 A similar section of a megasporangium. Here three germinated megaspores are to be seen forming an axial row. The lower one of the three that is the one nearest the food supply, is many times larger than the other two. The latter develop no further. The tapetum has vanished. (x 275)
- Text-fig 16 A nearly median section of a megasporangium. The functional megaspore has grown considerably in size. The tapetum has been absorbed and one of the other abortive megaspores is seen. Repeated free nuclear division has taken place. The large clear central vacuole is clearly defined and the parietal position of the cytoplasm and free nuclei represented. (x 275)

tegument. The vascular bundle from the axis divides as it enters the sporophyll, one part supplying the ovule and the other entering the sporophyll. The axis of the ovule lies practically parallel with the cone axis, so that the integument and micropyle are directed upwards.

The most important feature of the ovule is the entire absence of a second integument or aril. The presence of this structure is a characteristic feature of the Taxaceae. In Podocarpaceae it is an important structural feature of the seed, being well developed in *Podocarpus*, *Microcachrys*, *Sauegothaea* and *Phyllocladus*. In Text-figures 8, 9, 12, and 16, stages in the development of the ovule are indicated, but in none of these was there any evidence of a second integument. Text-figure 9 is a more highly magnified representation of the ovule shown in Text-figure 8. The single integument is here clearly shown terminating in a gaping mouth of the micropyle, the tubular passage of which attenuates near the apex of the nucellus. Three microspores are seen in this figure at the narrowest point of the micropylar tube. Two or three layers of cells at the apex of the nucellus become differentiated into a pollen cushion into which the pollen tubes penetrate. This is indicated in Text-figures 10, 11, 16, and 19. The remarkable protrusion of this tissue in *Sauegothaea* is evidently a special adaptation characteristic for that genus.

The Female Gametophyte

With the exception of *Microcachrys* which has only recently been investigated by the writer (1923) the details of megasporogenesis are practically unknown for the Podocarpaceae. In *Microcachrys* a single megaspore mother-cell appears deep in the central tissue of the sporangium. This is surrounded by a distinct tapetum of two or three layers of cells. The mother-cell undergoes division forming two cells in a row. These each undergo a division, but not simultaneously. The result of the second division is an axial row of four potential megaspores. Only one of these germinates, that is the innermost one—the one nearest the food supply. This becomes the functional megaspore.

In *Pherosphaera* a most unusual condition was observed. The early stages of megasporogenesis were not found, but an axial row was found in many sections. This consists of three spores, all of which have germinated, for they are enlarged and multinucleate. From the considerable number of sections of this stage examined it seems quite probable that a single mother-cell appears and this undergoes reduction division. Of the two resulting cells it would seem that only one of these divides so that there are only three cells in the axial row. The inner two of these are undoubtedly potential megaspores, but the third one cannot be actually so regarded as the second division of meiosis in that case has not occurred.

In *Phyllocladus* (Young, 1910) only three cells are likewise reported as forming the axial row. A similar condition seems to prevail in *Taxus*.

But the remarkable feature in *Pherosphaera* is that all three of the potential megaspores germinate and begin to produce prothalli. A very typical representation of this is shown in Text-figure 12. It will be seen from this figure that the innermost of the three megaspores has increased in size very much—being now several times larger than the other two. The middle one is next in size and the outermost one has increased least. All three have germinated, for all three have grown considerably and are multinucleate. From this striking and characteristic appearance, it would seem that the innermost one is the functional mega-

spore and the growth and development have been more rapid in it because it is nearest the food supply. The other two develop less rapidly in consequence. I have studied megasporogenesis in many Conifers, but I have never observed anything quite so striking as this. As a rule among Conifers, it is the innermost cell of the axial row which becomes the functional megaspore but there are some striking exceptions to this as in *Sequoia* (Lawson, 1904) and *Taxus* (Strasburger, 1904). In *Pherosphaera* there can be no doubt as to which is the functional spore.

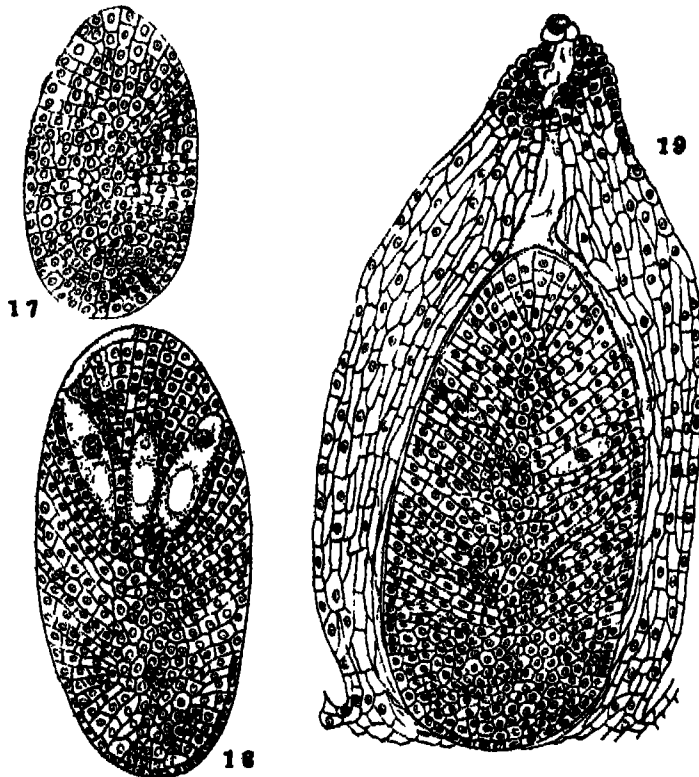
In making longitudinal sections of the strobilus at this time, the chance of obtaining a perfectly median section through the megasporangium is very small indeed. From the numerous sections taken, however, several beautiful examples were obtained. One of these is represented in Text-figure 12, where all three megaspores of the axial row are in the one section. Text-figure 13 is from a section not quite median in which only the functional megaspore is shown. The usual large central vacuole with parietal cytoplasm in which free nuclei are suspended is indicated. This figure is also intended to show definite organised tapetal cells three layers deep. The deeply staining nuclei and dense granular cytoplasm differentiate these cells very sharply from the surrounding tissue. This tapetum is shown very well in Text-figure 14. Here the large functional megaspore and one of the potential spores are seen. With the growth of the functional megaspore the tapetal cells gradually break down and their substance becomes absorbed until, as shown in Text-figure 12, all trace of this nourishing tissue has vanished. Text-figure 15 shows a later stage in the development of the functional megaspore with the two aborted spores above it. In Text-figure 16 is a still later stage. Here the central vacuole has reached its maximum size before cell wall formation begins. From the sections of this stage available it was impossible to make an accurate estimate of the number of free nuclei present in the parietal cytoplasm. It would seem, however, that at least six or seven successive nuclear divisions occurred to produce this effect. It is interesting to note that even as late as this stage—Text-figure 16—one of the other megaspores still persists.

In *Microcachrys* (Lawson, 1923) and most other Conifers, the non-functional aborted megaspores disappear at a much earlier period.

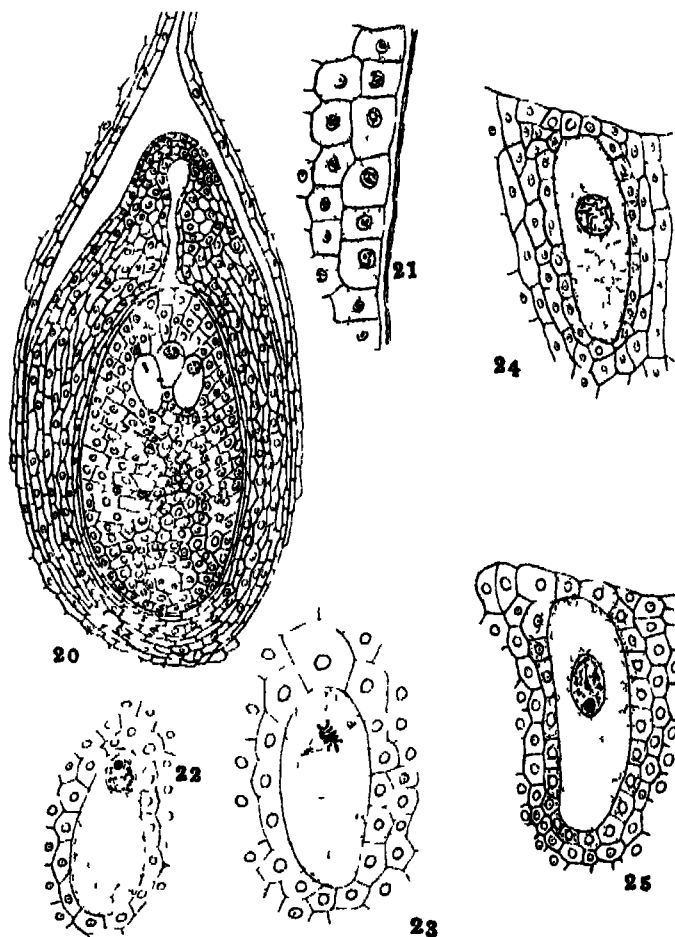
The early stages in the formation of the cellular prothallus were not observed, but the stage represented in Text-figure 17 shows quite clearly that this occurs in the usual way, namely, by the ingrowth of primary prothallial cells which encroach upon and finally obliterate the central vacuole. The establishment of cellular prothallial tissue probably occurs after the manner recently described for *Microcachrys* (Lawson, 1923). The rows of cells converging from the periphery to the centre as shown in Text-figure 17 can hardly be interpreted in any other way.

The fully developed prothallus is quite small when compared with other Conifers. None of the Taxodineae are characterised by large endosperms in the seed—certainly not as large as that of the Taxineae. The size of the prothallus as compared with surrounding structures in *Pherosphaera* is illustrated in Text-figures 17, 18, 19, 20. Text-figure 20 is taken from a fairly median section through the ovule just about the time of fertilisation. The prothallial tissue is not large as compared with the surrounding nucellar tissue. The endosperm enlarges slightly after fertilisation and during the development of the embryo, but this growth is not very great.

The megaspore membrane in *Pherosphaera* is a feature worthy of some consideration. It has been pointed out by Thomson (1905, 1909), and Young (1910) that the megaspore membrane of *Podocarpus*, *Phyllocladus*, *Dacrydium*, *Saxegothaea* and *Microcachrys* is thick, two-layered and highly suberised. The nature of this membrane stands in the greatest contrast to the condition found in the *Taxineae* where the megaspore membrane is very thin. In this respect *Pherosphaera* is unlike any of the *Podocarpaceae* investigated. The megaspore membrane in this genus is very thin and of very uncertain structure. It stands in the greatest possible contrast to that of *Microcachrys* which the writer has only re-



- Text-fig. 17 A nearly median longitudinal section of a young prothallus soon after cell formation has taken place. The characteristic rows of cells directed towards the centre indicate the original position of the primary cell or "Alveoli".
- Text-fig. 18 A median longitudinal section of a megasporangium. The germinating microspores on the apex of the pollen cushion and the course of the pollen tubes through the nucellar tissue are shown. The cellular prothallus with two young archegonia is also indicated. The figure also shows the very thin megaspore membrane enveloping the prothallus. (x 100).
- Text-fig. 19 A median longitudinal section of a prothallus showing the relative position of three nearly mature archegonia. It will be observed that the necks of the respective archegonia are widely separated from one another. A portion of a pollen tube is also seen at the apex (x 100).



- Text-fig 20 A median longitudinal section of a megasporangium showing the contained cellular prothallus. A pollen tube is seen penetrating the nucellus tissue. Oblique sections of three archegonia are to be observed near the centre of the upper half of the prothallus. The central cell of one of these is undergoing mitosis to form the ventral canal nucleus and the egg cell. ($\times 100$)
- Text-fig 21 This figure is taken from the lower half of the prothallus. It indicates the very thin nature of the megaspore membrane. ($\times 275$)
- Text-fig 22 A nearly median section of a very young archegonium. The large central nucleus lies at one end. The jacket cells have not yet been organised. ($\times 100$)
- Text-fig 23 A similar section of a slightly older archegonium. The central nucleus is undergoing mitosis to form the ventral canal nucleus and the egg nucleus. The organisation of the jacket cells is beginning. They are slightly differentiated from the other prothallial cells. ($\times 100$)
- Text-fig 24 A similar section showing a still older archegonium. The egg nucleus has a central position and the jacket is fully organised. Two of the neck cells are shown. ($\times 100$)
- Text-fig 25 A similar section showing the archegonium about the same stage. The lower region of the cytoplasm is becoming vacuolated. ($\times 100$)

cently investigated. Text-figure 21 represents a small portion of a longitudinal section of the prothallus in touch with the megaspore membrane. The latter has reached its maximum development at this time and in the figure it is represented very highly magnified. For other sections, such as in Text-figures 17, 18, 19, 20, at lower magnification the megaspore membrane is scarcely discernible.

The Archegonia

The archegonia are few in number. Three or occasionally four was the number most frequently met with. These are situated in the upper half of the prothallus as shown in Text-figures 18, 19 and 20. In the mature state their bases are close together, with but a single layer of cells between them, as in Text-figure 18. The apices of the archegonia diverge as development proceeds and eventually the necks are widely separated from one another. This curious orientation of the archegonia made it very difficult to obtain a median section. It was quite impossible to obtain median sections of more than one or two at most in one section. In the majority of sections examined the archegonia were cut tangentially—as shown in Text-figures 18 and 20.

The youngest stage observed in the development of the archegonia is shown in Text-figure 22. Here the central cell is fully organised with its large, deeply staining nucleus at one end. The cytoplasm is granular and vacuolated. Several instances of this were found showing the central cell varying in size. The nucleus in the central cell shown in Text-figure 22 is evidently preparing for mitosis. In this case there is no trace of the jacket cells having differentiated. In Text-figure 23 is represented a slightly later development. Here the mitotic spindle of the central nucleus is clearly shown. The chromosomes are at the equator of the spindle. This spindle evidently forms the ventral canal nucleus. The latter was not actually observed. The cells immediately surrounding this young archegonium are becoming more densely granular and they evidently form a single layer of nourishing jacket cells.

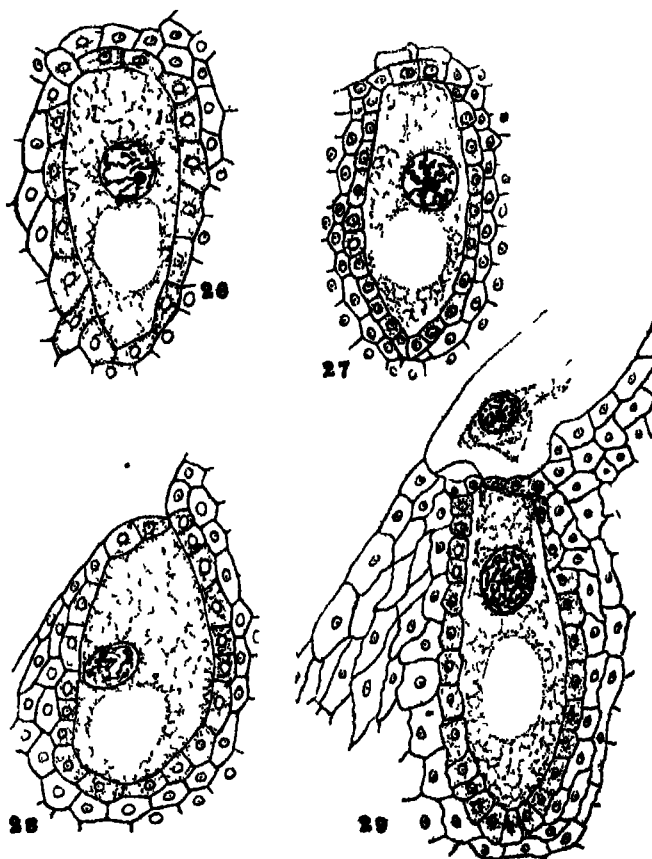
A slightly more mature condition is represented in Text-figure 24. The egg nucleus is almost fully organised and has taken up a central position. Two of the four neck cells are shown in this section. As no trace of the ventral canal nucleus was observed at this stage, it seems probable that it becomes disorganised immediately after it is formed. It is evident that this vestigial structure is evanescent and no trace of a cell membrane separating it from the egg was observed.

Another more mature archegonium is shown in Text-figure 25. The single layer of jacket cells is now well defined and the egg nucleus has enlarged considerably.

Two mature archegonia are represented in Text-figures 26 and 27. The very much enlarged egg nuclei are shown in the characteristic central position and the cytoplasm has likewise enlarged considerably. This enlargement is accompanied by the formation of a large vacuole in the rear of the nucleus. This is very characteristic of the mature archegonium as shown in the Text-figures 26, 27, 28 and 29. In Text-figure 28 is shown a similar condition but a slight cavity or depression in the side of the prothallus immediately over the neck cells is indicated. This archegonium is now ready for fertilisation.

It should be observed from Text-figures 18, 19 and 20 that the necks of the archegonia are widely separated from one another and do not open into a common archegonial chamber. Each archegonium has its own small and shallow depression

over the neck. From this it would seem that each is fertilised quite independently of the other. It is also interesting to note that the archegonia were never found at the apex of the prothallus; they were all laterally situated as shown in Text-figures 18 and 19. In this respect they differ from other Podocarpaceae and Taxineae. In *Sequoia* (Lawson, 1904), *Callitris* (Saxton, 1910) and *Araucaria* (Seward and Ford, 1906) the archegonia are laterally situated but more



Text-fig 26 A similar section showing a more mature archegonium. A characteristic large vacuole is now present in the rear of the egg nucleus (x 100)

Text fig 27 A similar section showing a mature archegonium ready for fertilisation. Two neck cells, the nourishing jacket cells, the vacuole and mature egg nucleus are clearly defined (x 100)

Text-fig 28 A mature archegonium ready for fertilisation showing how the neck cells open into a depression in the side of the prothallus (x 100)

Text-fig 29 A longitudinal section of a mature archegonium just about to be fertilised. The tip of the pollen tube with its contents lies in the cavity just outside the neck cells. (x 100)

markedly so than in *Pherosphaera*. In this latter genus, as shown in Text-figures 18 and 19, although the necks of the archegonia are laterally situated the main body of the egg cell is directed at an angle downward towards the centre of the prothallus.

Fertilisation.

The lateral position of the necks of the archegonia is co-related with the remarkable growth of the pollen tube. When the latter, in its descent through the nucellus, reaches the apex of the prothallus it continues to grow down one side of the prothallus for a considerable distance. This is shown in Text-figures 7, 11, 19 and 20. The course of the tubes seems to be well established at an early stage of the development of the prothallus, before the archegonia are developed. This feature recalls the case of *Sequoia* (Lawson, 1904) where the position and direction of growth of the archegonia are evidently influenced by the pollen tube and its contents. In this latter case the pollen tubes are well established in their course and direction before the cellular prothallus is formed and therefore much before the archegonia appear.

In *Pherosphaera* there is a suggestion of this same feature, and this may account for the lateral position of the archegonia and their development in a direction towards the pollen tubes. For instance, in Text-figure 19 one may see the pollen tube extending nearly half the length of the prothallus and an archegonium developing towards it.

Upon reaching the shallow cavity above the neck of the archegonium the pollen tube spreads at the tip and presses close to the neck cells. Such a condition is shown in Text-figure 29. Here the body cell is shown in the tip of the tube suspended in the tube cytoplasm. The nucleus of the body cell is very large, and its chromatin in the spireme stage preparing for mitosis. Unfortunately the male gametes themselves were not found, but if one may draw analogies from the fertilisation observed in other Conifers, it would be almost safe to predict that only one of the male gametes is functional in this case.

The Embryo

The early stages of the pro-embryo were unfortunately not found in the material collected, but from the abundance of the later stages such as that shown in Text-figures 30 and 31, it seems quite evident that at least two or three of the archegonia become fertilised and develop embryos. No evidence was found to show the plug in the base of the archegonium or the thick cellulose cap of the terminal cells of the embryo which has been described by Coker (1902) and others for *Podocarpus*.

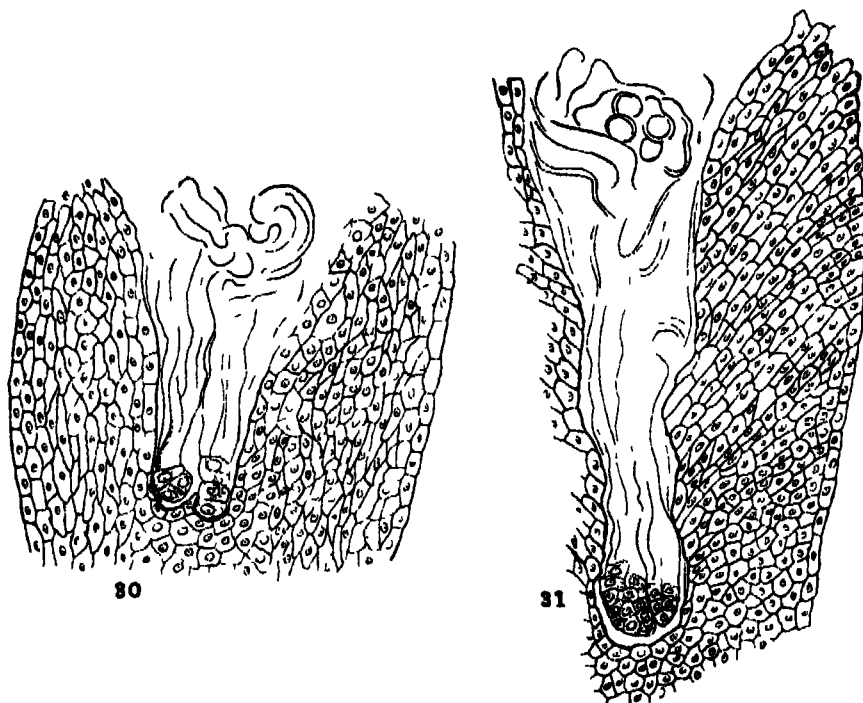
It would seem that the whole apex of the prothallus collapses under the great growth of the suspensor cells. This is shown in Text-figures 30 and 31. In Text-figure 30 two embryos with their very long twisted suspensors are seen, the tissue above the suspensors has completely broken down and the space becomes filled with the coils of the elongating suspensor cells. The embryo proper is carried deep into the endosperm tissue and the breaking down of the prothallial cells—evidently enzyme action—in front of the advancing embryo is quite evident. These two embryos are obviously from separate archegonia.

A later stage showing two embryos is illustrated in Text-figure 31. One of these embryos is evidently being absorbed by the other which is much larger.

A full comparative account of the embryo in the Coniferales has recently been published by Buebbolz (1926). In this work the embryology of the *Podocarpaceae* is considered. In this connection it is only necessary to say that in the stages of the embryo of *Pherosphaera* examined there were no features observed that could be characterized as typical of the *Podocarpaceae*.

As a result of this enquiry it seems quite obvious that in the gametophyte

structures and embryo of *Pherosphaera* there are no features which justify our classifying this genus among the *Podocarpaceae*. It bears no essential resemblance to *Podocarpus*, *Dacrydium*, *Microcachrys*, *Saxegothaea* or *Phyllocladus*.



Text-fig 30 A longitudinal section of the prothallus after fertilisation. Two embryos from separate archegonia, are seen penetrating the prothallial tissue. The archegonial region of the prothallus becomes completely disorganised, and filled with the long twining coils of the suspensor cells. (x 100)

Text-fig 31 A similar section showing the great length of the suspensor and the deep penetration of the embryo into the prothallus. (x 100)

Summary

- 1 The mature microspores are quite small, being about half the size characteristic of the *Podocarpaceae*.
- 2 There are three small symmetrically arranged wings to the pollen.
- 3 The microspore at the time of pollination contains but two nuclei—the tube nucleus, and the generative nucleus.
- 4 No trace of vestigial prothallial cells was found. In this respect *Pherosphaera* differs from all other genera of the *Podocarpaceae*.
- 5 The ovulate strobilus consists of a series of spirally arranged megasporophylls each bearing a single erect ovule on the adaxial face very close to the cone axis.
- 6 There is but a single integument. No trace of an aril or second integument is present. This is quite exceptional for the *Podocarpaceae*.

- 7 A single megaspore mother-cell gives rise to three potential megaspores forming an axial row
8. All three megaspores germinate The distal one undergoes free nuclear division but enlarges very little The middle one undergoes repeated free nuclear division and enlarges considerably The basal one enlarges more rapidly than the others and becomes the functional megaspore This condition is unique for the Conifers
- 9 Cellular prothallial tissue is formed only in the basal megaspore, the other two eventually become absorbed
- 10 Prothallial tissue or endosperm is formed in the normal way
- 11 The megaspore membrane is very thin and almost negligible This character also is quite exceptional for the Podocarpaceae
- 12 The archegonia are three or four in number, but do not occur at the apex of the prothallus The necks of the archegonia are laterally situated nearly half-way down the length of the prothallus
- 13 The pollen tubes have established their course before the archegonia appear, and the latter extend their growth towards the tubes which have in the meantime extended a great distance between the prothallus and the nucellus
- 14 A ventral canal nucleus is produced
- 15 Each archegonium has a small shallow depression over the neck cells and into this the end of the pollen tube, with its contents, enters
- 16 Two or three archegonia become fertilised and each produces an embryo
- 17 As the suspensors develop the entire archegonial region of the prothallus breaks down and the embryos are carried deep into the prothallial tissue

The procuring of material for this investigation, from Tasmania and the Blue Mountains of New South Wales has entailed considerable expense To meet this I am indebted to the University of Sydney for a grant of money from the McCaughey Research Fund

I also desire to express my thanks to my Laboratory Assistant, Mr O D Evans, for valuable help in the collection of material

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EXPLANATION OF PLATE XLIV

Pherosphaera Fitzgeraldi F v M.

Postscript, added 5th November, 1923 —

In a recent paper on the Taxaceae Pilger (Botanische Jahrbucher, 54, 1917, 1-43) gives a critical review of the recent work on this group of Conifers. He classifies the Podocarpaceae under four groups, 1 *Pherosphaeroideae*, 2 *Acmopyloideae*, 3 *Podocarpoideae*, 4 *Phyllocladoideae*.

In view of the new and important facts revealed by the present investigation of the gametophyte structure of *Pherosphaera*, a modification of Pilger's classification seems necessary. *Pherosphaera* shows no close relationship to the Podocarpaceae or to the Taxineae.

NOTE ON THE GENUS *SYNECHOCERA*, WITH DESCRIPTION OF A NEW SPECIES

By A. THÉRY, Correspondant du Muséum de Paris

(Communicated by H. J. Carter, B.A., F.F.S.)

(One Text-figure)

[Read 31st October, 1923]

The species of the genus *Synechocera* H.D. are not common in collections. Only two are known at present, one from Ambouina described in 1801, the other native of Australia (Swan River). In his "Genera," Kerremans, who had not seen insects of this genus, gave only a very brief diagnosis, after H. Deyrolle, good for the time in which it was published, but to-day quite insufficient. Deyrolle did not mention the shape of the tarsal claws, very important for the classification of the tribe *Agriini*, and omitted other important characters. However, he was struck by the shape, abnormal in this tribe, of the sternal cavity.

I think it is useless to redescribe the genus and hope it will be sufficient to give a complete description of the new species here described including some generic characters which have never been published.

SYNECHOCERA TASMANICA, n. sp.

Length, 9.5 mm, width, 2.25 mm. Very elongate, moderately attenuated anteriorly and posteriorly, very depressed above and beneath, entirely black, more shining dorsally and covered with a whitish and very scattered pubescence.

Head subglobose, deeply sulcate in the middle, as if divided into two rounded lobes; eyes not prominent, epistoma hollowed, short and wide, impressed, antennal cavities very wide, contiguous; antennae moderately elongate, nearly reaching the anterior cotyloid cavities, 1st joint thick, 2nd at least as thick as the 1st and nearly as long, the following 3 elongated, the others rather close and dentate, the poriferous pits are very small, rounded, terminal and beginning at the 6th joint. Pronotum circular, completely bordered laterally, anterior margin feebly bisinuate and moderately projecting at the middle; anterior angles acute, posterior obtuse and blunted at the tip, the base feebly bisinuate, the disc with a groove crossing a depression situated anteriorly, the anterior margin transversely and finely striolated in the middle, surface without punctuation, looking corroded as the elytra; between the base of the pronotum and of the elytra, there is on each side a triangular space allowing the dorsal face of the mesosternum to be seen—a very rare character in the Buprestidae.



S. tasmanica

Scutellum wider than long, subtriangular, acuminate posteriorly.

Elytra narrower at the base than the pronotum, as broad

as the latter at the posterior fourth, basal lobes rounded, shoulders scarcely angulate, the sides feebly sinuate, straight as far as the posterior fourth and moderately enlarged posteriorly, thence feebly attenuated to the apex where the sutural angle is well marked, the lateral margins are not denticulate. Elytra feebly bordered up to the posterior fourth, the last abdominal segment uncovered, rounded at the apex, which is narrowly testaceous. The disc of the elytra is impressed near the base with nearly inconspicuous median costae, surface without distinct punctuation, looking as if slightly corroded, the humeral callus smooth, shining and prominent. Mentum large and triangular, cheeks unarmed, prosternum without chin-piece, hollowed anteriorly, the prosternal prominence scarcely narrowed between the anterior coxae, rather wide, without marginal striae, the apex simple and angulate, the sternal cavities constituted only by the branches of mesosternum which are relatively long, converging posteriorly, not soldered together, but united beneath at a point, flanks of the mesosternum very long, longer than the half of the metasternum, posterior coxae rather narrow, slightly projecting anteriorly at the lateral margin, the posterior margin nearly straight, slightly hollowed at the internal side. Abdomen flattened and slightly depressed in the middle, the suture between the 1st and 2nd segments obliterated in the middle, these two segments together as long as the following three, the last segment completely rounded and produced at the apex by a thin, smooth and shining lamella, the whole surface slightly corroded and without distinct punctuation. The sides of the 3rd segment with a transverse wrinkle at the anterior margin.

Legs short, all femora fusiform, the anterior strongly grooved to receive the tibiae, the following much less strongly, anterior femora with a small lamellate expansion close to the knee, anterior tibiae with a rather strong spine on the external margin at the apex, tarsal joints short and nearly equal, claws simple, not appendiculate.

Habitat Tasmania. A single specimen in my collection.

This new species is distinct from *S. elongata* Thoms. by its much larger size (9.5 mm. instead of 6 mm.) and different habitat. The colour is uniformly black but Thomson's description is so short that it is impossible to make a complete comparison. I consider the genus *Synechocera* should be placed near *Strigula* Keri, with which it has a rather strong likeness in the shape of its circular pronotum, but it differs in the shape of the sternal cavity and the simple claws.

ON SOME AUSTRALIAN GALERUCIDES (COLEOPTERA,
CHRYSOMELIDAE).

By ARTHUR M. LEA, F.E.S.

(Sixty text-figures.)

[Read 26th September, 1923.]

The Galerucides have been more neglected than any other subfamily of the Australian Chrysomelidae, and this is somewhat remarkable, in consideration of the destructiveness of many of the species, and the ease with which they may be obtained. Here I purpose dealing only with *Monolepta* and the allied genus or subgenus *Candesea*.

MONOLEPTA

This genus is abundantly represented in most parts of Australia, and all the species are leaf- or flower-eaters, some being serious pests, such as *M. australis* to a great variety of plants in New South Wales and Queensland, and *M. diversa* to the grapevine in New South Wales and South Australia. Some of the species vary in colour to a certain extent, and the patterns in degree, the infuscation of the antennae and legs also varies, not much dependence is to be placed upon the colours of the metasternum and abdomen, as these often vary, on the same species, from entirely pale to entirely black. The under surface and legs are usually more or less pubescent, the upper surface is usually glabrous, except that there are frequently a few short hairs or setae at the sides of the elytra near apex, also each hind angle of the prothorax, on many species, has a fairly long hair or seta, but it is so often abraded or obscured that it appears undesirable to note it in descriptions. There is usually a groove between the eyes, usually deep and gently curved, sometimes foveate in the middle, usually in front of its middle there is a small depression (often triangular) bounded on each side by a small elevation or subtubercular swelling. The eyes are usually of large size and with well-defined facets, but when, owing to the shrinkage of their contents, the facets are whitish, they appear to be larger than on specimens whose eyes are normally black. The prothorax usually has a well-defined transverse median depression, but it is often enfeebled or interrupted in the middle, usually the punctures are smaller within the depression than on the adjacent parts. On pale species the inner margins of the elytral epipleurae are nearly always narrowly black or deeply infuscated, although the black part is invisible from above, and is difficult to see when the metasternum is also black, when the hind tarsi are pale their extreme base is usually black. Practically the only distinguishing feature between *Monolepta* and *Candesea*, as regarded by Blackburn was the length of the elytral

epipleuræ, if these are suddenly narrowed and vanish before the middle, he referred the species to *Monolepta*, if they continued well beyond the middle of the abdomen he considered it a *Candessa*, and in this I have usually followed him. Jacoby considered that several species standing in *Monolepta* should be transferred to *Candessa*, although he did not specify such species by name, to see the epipleuræ clearly the insect must be examined on its back, and there are so many more or less intermediate species that the validity of the latter genus is open to doubt. On many species there is a vague impression across the basal third of elytra, sometimes accentuated by a feeble swelling on each side near the scutellum, but it is so feeble that it cannot be usefully employed in descriptions. Owing to the frequent postmortem contractions of the abdomen, it is often difficult to decide as to whether a shallow subapical depression or fovea is an indication of sex or not, but the male often has a deep narrow impression on each side of the median third at apex. The combined length of the second and third joints of antennæ is usually slightly more or slightly less than the fourth, but sometimes they are less than half its length, the third is usually slightly longer than the second, but its apex on many species is oblique, so that from some directions it appears to be slightly shorter, the apical joint is usually wider than deep, so that its width varies with the point of view—from the side it sometimes appears to be very narrow, with the apical half incurved. The basal joint of the hind tarsi is always long, being at least almost as long as the rest combined, up to fully twice their length, but it sometimes varies slightly in length sexually. There are many other pale species before me, but as they are usually represented by single specimens, without very distinctive characters, it was not considered advisable to name them, some dark species, and others that are certainly distinct, but whose antennæ or tarsi were damaged, were also passed over.

It is difficult to give a satisfactory table of the species, as the structural distinctions are usually of a comparative nature (as the proportions of certain joints of the antennæ and tarsi), and moreover, some are sexually variable, the markings also vary considerably in extent and definition, and the shades of colour depend to a certain extent on the method of preservation. As a partial aid to identification, however, the species have been divided into groups according to their usual colours and markings. Where the species is unknown to me, in nature, this is indicated by an asterisk (*).

Group 1 Prothorax and elytra entirely pale (the extreme inner margins of the epipleuræ usually excepted, the suture is also sometimes narrowly infuscated, and occasionally the elytra appear infuscated posteriorly, owing to the black of the wings showing through)

<i>abundans</i> Lea	<i>dilutior</i> Blackb
<i>alba</i> Lea	<i>exsanguis</i> Lea
<i>albinervosa</i> Lea	<i>flavoangusta</i> Lea
<i>albipennis</i> Lea	<i>fragilis</i> Lea
<i>angustifusca</i> Lea	<i>foveiceps</i> Lea
<i>basiceps</i> Lea	<i>foveiventris</i> Lea
* <i>brevior</i> Blackb	<i>fumaticornis</i> Blackb
<i>coquata</i> Blackb	<i>hypomela</i> Lea
<i>cribriceps</i> Lea	* <i>impressa</i> Weise
<i>cribrosa</i> Lea	<i>incisiventris</i> Lea
<i>cryptomela</i> Lea	* <i>incomta</i> Weise
* <i>debilis</i> Blackb	<i>inconspicua</i> Black
<i>depressa</i> Lea	<i>indistincta</i> Lea

<i>*ingenua</i> Weise	<i>picticollis</i> Blackb, lar
<i>integricollis</i> Lea	<i>*pubipennis</i> Weise
<i>metasternalis</i> Lea	<i>*scutellata</i> Jac
<i>mimetus</i> Lea.	<i>*simulatrix</i> Blackb
<i>nitida</i> Lea	<i>sordidula</i> Blackb
<i>obscuripes</i> Lea	<i>stenocera</i> Lea
<i>orthodoxa</i> Lea	<i>subvigilans</i> Lea
<i>pachycera</i> Lea	<i>tarsalis</i> Blackb
<i>pallens</i> Lea	<i>tasmanensis</i> Lea
<i>pullidula</i> Lea	<i>tropica</i> Lea
<i>phanophila</i> Lea	<i>vigilans</i> Lea

Group 2 *Prothorax entirely pale, elytra entirely dark*

<i>abaceta</i> Lea	<i>*meyricki</i> Blackb
<i>albicollis</i> Lea	<i>minuscule</i> Lea
<i>antennalis</i> Lea	<i>modesta</i> Blackb
<i>benallae</i> Blackb	<i>monobia</i> Lea
<i>*blanda</i> Weise	<i>*nitidipennis</i> Lea
<i>cribripennis</i> Lea	(<i>melancholica</i> Blackb, n pr)
<i>*crocicollis</i> Germ	<i>*occidentalis</i> Blackb
<i>erythroderes</i> Lea.	<i>ordinaria</i> Blackb
<i>femoralis</i> Allard	<i>pallidicollis</i> Lea
(<i>nigricornis</i> Blackb)	<i>pictifrons</i> Blackb
<i>interrupta</i> Lea	<i>soror</i> Lea
<i>irrasa</i> Lea	<i>trichoptera</i> Lea
<i>*lebiaeformis</i> Boi	

Group 3 *Prothorax entirely pale, elytra with distinct markings* (some species with the markings consisting of sutural infuscations might almost be referred to Group 1)

<i>abaceta</i> Lea, var	<i>intertexta</i> Blackb
<i>australis</i> Jac	<i>laticollis</i> Lea
(<i>rosea</i> Blackb)	<i>leptospermi</i> Lea
<i>biguttigera</i> Blackb	(<i>trifasciata</i> Lea, n pr)
<i>bivittialba</i> Lea, ♀	<i>melanostetha</i> Lea
<i>caviventris</i> Lea	<i>*mimetica</i> Weise
<i>*contempta</i> Weise	<i>*nebulosa</i> Weise
<i>costipennis</i> Lea, forms 2 3 4	<i>octonotata</i> Lea
<i>dimidiata</i> Jac	<i>polluta</i> Lea
<i>dispar</i> Lea, in part	<i>*pubescens</i> Weise
<i>divisa</i> Blackb	<i>*quadrupunctata</i> Fab
<i>elytrura</i> Blackb	<i>*quinquemaculata</i> Weise
<i>*eyrensis</i> Blackb.	<i>rubrofasciata</i> Lea
<i>fasciculata</i> Lea	<i>semiflava</i> Lea
<i>*fibularis</i> Weise	<i>*sparsipennis</i> Blackb
<i>flavoinclusa</i> Lea	<i>substriata</i> Lea
<i>flavosuturalis</i> Lea	<i>subsuturalis</i> Blackb
<i>froggatti</i> Blackb	<i>subtricolor</i> Lea
<i>*haemorrhoidalis</i> Fab	(<i>tricolor</i> Blackb, u. pr)
<i>heterodoxa</i> Lea	<i>suturalis</i> Boi
<i>*humeralis</i> Weber	<i>tepperi</i> Blackb
<i>*instabilis</i> Weise	<i>terminalis</i> Weise

- **tetrastictoptera* Lea. *variegata* Blackb
 (*quadrimaculata* Jac, n pr) *virgata* Lea
trimorpha Lea, forms 1 and 2

Group 4 *Prothorax of two colours*

- | | |
|-----------------------------------|------------------------------|
| <i>aberrans</i> Lea | <i>laterwana</i> Lea |
| <i>acaciae</i> Lea | <i>medioflava</i> Lea |
| * <i>ambigua</i> Weise | <i>megalops</i> Lea. |
| <i>arida</i> Lea | * <i>patagiata</i> Weise |
| <i>bivitticollis</i> Lea. | <i>picticollis</i> Blackb |
| <i>castigata</i> Lea. | var <i>melanoptera</i> Lea. |
| (<i>margimcollis</i> Lea, n pr) | * <i>signifera</i> Weise. |
| <i>costipennis</i> Lea, form 1 | <i>sordidula</i> Blackb, var |
| * <i>descripta</i> Weise | <i>trimorpha</i> Lea, form 3 |
| * <i>dorsalis</i> Weise. | <i>trivitticollis</i> Lea |
| <i>fasciatipennis</i> Blackb | * <i>typographica</i> Weise. |
| * <i>figurata</i> Weise | (<i>hieroglyphica</i> Jac) |
| <i>implicata</i> Blackb | <i>vittimedia</i> Lea |
| var <i>extrema</i> Blackb | * <i>vittulata</i> Weise |
| <i>intricata</i> Lea | |

Group 5 *Prothorax and elytra entirely dark*

- | | |
|----------------------------|--------------------------------|
| <i>dolichognatha</i> Lea | <i>parvonigra</i> Lea |
| <i>germani</i> Jac | <i>picticollis</i> Blackb, var |
| <i>inflata</i> Lea | * <i>punctigera</i> Weise |
| <i>mediofusca</i> Lea | <i>quaesita</i> Blackb |
| * <i>nigricollis</i> Weise | <i>submetallica</i> Lea. |
| <i>ovata</i> Lea | <i>usitata</i> Lea |

Group 6 *Prothorax entirely dark, elytra of two colours*

- | | |
|----------------------------|----------------------------|
| * <i>albotincta</i> Blackb | <i>dispar</i> Lea, in part |
| <i>angulata</i> Blackb | <i>minima</i> Allard |
| <i>bivittialba</i> Lea | (<i>alpina</i> Blackb) |

Notes on the above Groups

M melanocephala Fab, of Masters' Catalogue has been transferred to *Agelastica*

M simulatrix Blackb. was described as "*fusca*," but in Blackburn's table was referred to AA, BB, "Elytra testaceous, or reddish, or brownish-testaceous"

Some specimens of *M arida* Lea have very faint prothoracic markings, and might be regarded as belonging to Group 3

Regarding *Candesea* as a section of *Monolepta*, its Australian species would be distributed as follows —

Group 1

- | | |
|---------------------------|-----------------------------|
| <i>palmerstoni</i> Blackb | <i>setipennis</i> Lea |
| <i>parvopunctata</i> Lea | <i>stenopleura</i> Lea |
| <i>rudis</i> Lea | <i>tetrasticta</i> Lea, var |

Group 2

- | | |
|--------------------------|-----------------------|
| <i>inermicollis</i> Lea. | <i>lata</i> Lea, var. |
|--------------------------|-----------------------|

Group 3

<i>bimaculata</i> Jac (<i>sculpta</i> Blackb.)	<i>leai</i> Blackb
<i>bimaculimgra</i> Lea	<i>maculipennis</i> Lea.
* <i>bovilli</i> Blackb	<i>melanocera</i> Lea.
<i>decipiens</i> Lea.	<i>sculptipennis</i> Lea
<i>distincta</i> Lea.	<i>seminigra</i> Lea
<i>lata</i> Lea.	<i>tetrasticta</i> Lea.

Group 4

<i>avicenniae</i> Lea, in part	<i>ziczac</i> Lea
--------------------------------	-------------------

Group 6

avicenniae Lea, in part

Regarding *Morphosphaera cincta* Blackb as a *Monolepta*, it would belong to Group 3, of *Luperus australis* Jac and *L. proemarginatus* Jac, so regarded, the former would belong to Group 5, the latter to Group 3. The species of *Luperodes* recently named by Weise would be distributed as follows — *L. gregalis* and *L. parisi* to Group 1, *L. epipleuralis* to Group 3, *L. aestivus*, *L. humilis* and *L. procerulus* to Group 5, and *L. bilineatus* and *L. tantulus* to Group 6.

MONOLEPTA SORDIDULA Blackb

In the description of this species only the antennae (after the first three joints) were noted as being infuscated, but (as with almost all the pale species) the extreme edge of each of the elytral epipleurae is more or less deeply infuscated or black, the narrow infuscation on some specimens is confined to about the basal half, but on some it extends to near the apex, on many specimens the elytra appear to be infuscated on and about the apical slope, but this is due to the dark wings partly showing. The under surface is often entirely pale, but frequently is infuscated, the infuscation varying in intensity and extent, on many the abdomen is quite black, on Tasmanian specimens the abdomen is black, and metasternum almost so, with the suture and scutellum also infuscated. The pronotum on some specimens has five feeble infuscations — one in the middle of the base, the others in a semicircle about it, the infuscations are on faint elevations (these can often be traced on an entirely pale surface) due to sparsity of punctures, on two specimens (from Sydney) the infuscations appear as distinct spots. The punctures of the upper surface are comparatively coarse and slightly rugose; the elytra from some directions appear to have feeble remnants of striation. On several pairs, taken *in cop*, the male has the basal joint of the hind tarsi slightly longer than the rest combined, on the female it is slightly shorter than them. It is one of the comparatively few widely distributed species, occurring in Queensland (Cairns, Gympie and Mount Tambourine), New South Wales (Dorrigo, Sydney, Galston, Jenolan and Mittagong), South Australia (Mount Lofty), Tasmania (Wilmot, Strahan, Cradle Mountain, Denison Gorge, Avoca and Mount Wellington) and King Island, as well as the type localities in Victoria.

MONOLEPTA BIGUTTIGERA Blackb (Text-fig 1.)

A pattern of the elytral markings is given for purposes of comparison.

MONOLEPTA PIOTICOLLIS Blackburn (Text-figs 2-5)

Specimens from South Australia vary in colour from having the upper surface entirely pale, to those in which the prothorax and elytra (but not the scutellum) are entirely dark, usually there are two large spots on the pronotum, varying in size and intensity. The under surface is usually entirely pale, but on some specimens is partly dark. Blackburn said he had not seen "any example in which the suture is wholly dark so as to divide the testaceous spot"; there are, however, three such specimens before me, from Lucindale, and of these a male is still fastened to a female whose elytra are entirely black, these mottled specimens, in Blackburn's table, would be associated with *M. humeralis*, from which they differ in having the spot median instead of humeral.

Var. MELANOPTERA, n. var.

From New South Wales (Dorrigo, Wollongong, Sydney, Galston, Gosford, Forest Reefs and Mount Victoria) and Queensland (Mount Tambourine) there are specimens that have the interocular black spot, and two black prothoracic spots as in the typical form, but the elytra entirely black, they agree so closely in structure with a cotype, and other specimens from Victoria and South Australia, that I cannot regard them as distinct, but as there are 26 specimens of the form before me, and I have seen no other forms of the species from New South Wales and Queensland, it seems desirable that it should have a name.

MONOLEPTA FUMATICORNIS Blackburn

Blackburn wrote of this species "uniformly pale testaceous, except the antennae" but (as on most species that at first, except for the antennae, appear to be entirely pale) the elytral epipleurae are narrowly margined with black at the base, and the extreme base of the hind tarsi is black.

MONOLEPTA IMPLICATA Blackburn (Text-figs 6-9)

(*M. contexta* Weise)

A very variable species, known only to Blackburn from Queensland, but which occurs also in the Northern Territory (Melville Island) and New South Wales (Tweed River). The usual mark on the middle of the pronotum resembles a rather loosely-jointed Y, more rarely (as on the type) an M, but occasionally the median mark is absent, although the lateral infuscations appear to be always present on the typical form and all the varieties, there appears also to be always present a longitudinal infuscation between the eyes, and the side of each elytral epipleura is narrowly infuscated or black about the base. The elytral infuscations consist of more or less elongated spots, angularly conjoined, or even forming zig-zag fasciae (as on the variety *extrema*), other varieties, of which there are more than one specimen before me, may be noted.

M. contexta Weise appears to be a synonym of this species and *M. descripta* Weise must be very close, although apparently differing in the length of the third joint of antennae, quite possibly others of his names are synonymous or varietal.

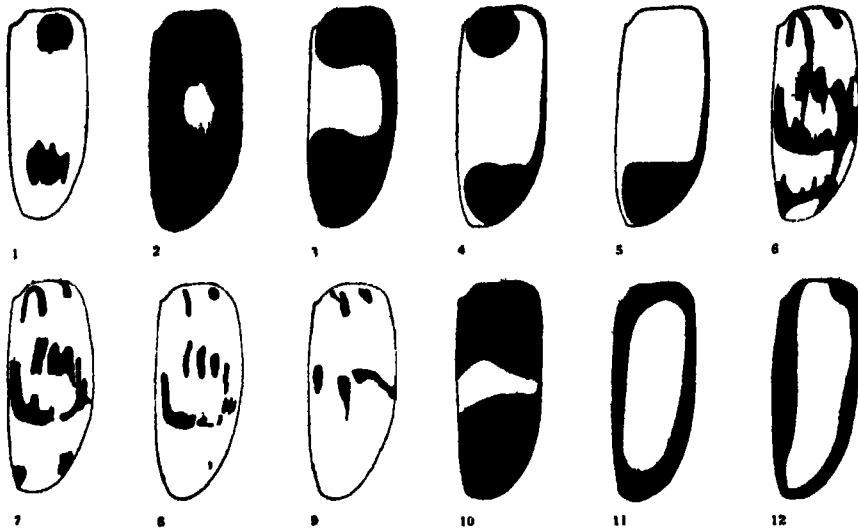
VAR. B. Prothorax with a median Y (usually consisting of three disconnected vittae) and the sides infuscated; elytra entirely pale (except for the epipleural margins), but with the angles of the folded wings usually showing as faint infuscations.

Hab.—Melville Island and Northern Queensland.

VAR. C. Median Y of prothorax faint or absent, each elytron with a vague curved infuscation extending backwards from the shoulder to near the apex (on

very pale specimens this infuscation is apparently intensified by the wing beneath it, but it is traceable on an uplifted elytron)

Hab—Kuranda and Cairns



Text-figures 1-12 Elytral Patterns of species of *Monolepta*
 1 *M. biguttigera* Blackb 2-5 *M. picticollis* Blackb 6-9 *M. implicata* Blackb
 10 *M. rubrofasciata* Lea 11 *M. flavoocclusa* Lea 12 *M. virgata* Lea

MONOLEPTA PICTIFRONS Blackb

On two cotypes, on a specimen from Gosford, and another from Dorrigo, the elytra, when closely examined, are seen to be darker about the suture and sides than on the intervening parts, although at first glance they appear to be entirely black. On several other specimens from New South Wales, the elytra are either entirely deep black, or with a faint dilution about the base.

MONOLEPTA AUSTRALIS Jac (Luperodes) * (*M. rosea* Blackb)

This species is abundant in the northern coastal districts of New South Wales and in Southern Queensland, it is probably the most destructive species of the genus in Australia, the commonest form has a wide reddish basal fascia on the elytra and two small spots near the suture about the middle, frequently the two spots are absent, specimens with them absent were commented upon by Weise as "Var. a"; rarely the spots are combined to form an abbreviated median fascia. I concur with Weise in regarding *M. rosea* as a synonym. There is also a *Luperus australis* of Jacoby but it is a very differently coloured species.

MONOLEPTA TERMINALIS Weise (Text-fig 30)

A curious blood-red species with dark elytra, except for their tips, it has been taken in the Queensland National Park as well as on Mount Tambourine.

* Jacoby, Proc Zool Soc Lond, 1882, p 56

MONOLEPTA SCUTELLATA Jac †

Weise records this species as occurring in Queensland; it was described originally as from New Guinea

MONOLEPTA TYPOGRAPHICA Weise

(*M. hieroglyphica* Jac. ‡)

I have not seen the description of *M. typographica*, but *M. hieroglyphica* was described originally as from New Guinea, Weise in recording it from Queensland noted the names as synonymous.

MONOLEPTA GERMARI Jac

The type of this species belongs to a comparatively rare form of a common Queensland insect, the terminal joints (usually two, but sometimes three) of its antennae, as well as the basal ones and the front tibiae, are pale. On many specimens only the three basal joints of antennae are partly pale, the others being entirely dark, but the two apical ones, on close examination, are often seen to be slightly paler than the preceding ones, usually only the front knees are paler than the rest of the legs, occasionally the antennae and legs are entirely dark. The upper surface is usually uniformly dark metallic-blue or purple, but sometimes the head and prothorax are of a different shade from the elytra, occasionally they have a more or less greenish gloss; the under parts frequently have a purplish gloss.

Two specimens, from Thursday Island, may also belong to the species, they have the upper surface purplish, with a bronzy gloss, antennae black except for three basal joints, and base and apex of femora, most of tibiae and parts of tarsi flavous.

MONOLEPTA DIMIDIATA Jac

Four specimens, from Cairns and Thursday Island, probably belong to this species, but all have the tibiae, tarsi and apex of femora distinctly black, not "sometimes obscure fuscous", the elytra also have small but quite sharply defined punctures, although Jacoby wrote "elytra not visibly punctured." He wrote of the male "Elytra with a short costa at the middle near the suture." The only male before me has a strong curved costa on each elytron, marking the summit of an elevation which is abruptly terminated, so that from the side it almost looks like a tooth.

MONOLEPTA RUBROFASCIATA Lea. (Text-fig 10)

Several specimens from northern Queensland belong to this species, but have the legs almost entirely black.

MONOLEPTA LEPTOSPERMI, nom. nov.

(*M. trifasciata* Lea, 1898, nom. praecox.)

The types were obtained on tea-trees (*Leptospermum* sp.) A specimen from New South Wales (Sydney) and another from Queensland (Mount Tambourine) apparently belong to this species, but differ from the typical specimens in having no basal fascia on the elytra, and the median one reduced in extent, both in length and width. Jacoby used the name *trifasciata* for a *Monolepta* in 1896, and also for a *Candesea* in 1900.

† Jacoby, Ann. Mus. Civ. Gen., 1886, p. 93.

‡ Jacoby, Ann. Mus. Civ. Gen., 1905, p. 39.

MONOLEPTA CASTIGATA, nom. nov
(*M. marginicollis* Lea, 1898, nom. praecoc.)

M. marginicollis was used by Jacoby in 1896.

MONOLEPTA NITIDIPENNIS, nom. nov
(*M. melancholica* Blackb., 1886, nom. praecoc.)

M. melancholica was used by Jacoby in 1896.

MONOLEPTA SUBTRICOLOR, nom. nov
(*M. tricolor* Blackb., 1886, nom. praecoc.)

M. tricolor was used by Fairmaire in 1888.

MONOLEPTA TETRASTICTOPTERA nom. nov
(*M. quadrimaculata* Jac., 1886, nom. praecoc.)

M. quadrimaculata was used by Goldfuss in 1805, the name later being treated as a synonym of *M. bioculata* Fab., Jacoby also used the name *quadrimaculata* for a *Canderea* in 1900.

MONOLEPTA DIVINA Blackb., 1888; also Jacoby, 1899
MONOLEPTA MODESTA Blackb., 1888, also Allard, 1890, as a subspecies of
M. albofasciata

Attention is called to these twice used names, but as the later ones are not for Australian species, it is not here proposed to suggest new names.

LUPERUS PICEOMARGINATUS Jac.

Nine specimens, from the Cairns district, probably belong to this species, and certainly to *Monolepta*, but they differ from the description in being larger (3.3-7.5 mm.), some of them have the frontal tubercles flavous, but on others they are black, the disc of the pronotum is traversed by a feeble impression, although Jacoby described it as "without depression."

Group 1 Prothorax and elytra entirely pale (the elytral epipleurae and suture often excepted).

a Prothorax without distinct median transverse impression.

MONOLEPTA CRYPTOMELA, n.sp.

♂—Pale castaneo-flavous, inner margins of elytral epipleurae and extreme base of hind tarsi black, fourth to eleventh joints of antennae partly or entirely infuscated.

Head with interocular groove triangularly dilated in middle. Eyes large and prominent. Antennae long and thin, second joint just perceptibly longer than third, their combined length almost equal to fourth. Prothorax with sides almost straight, with a scarcely traceable remnant on each side of the median impression, punctures rather dense and sharply defined, although somewhat rugose and not very large. Elytra subelliptic-ovate, greatest width almost twice that of prothorax, punctures near base slightly larger than those of prothorax, and sharply defined even near apex; epipleurae scarcely traceable beyond hind coxae. Apical segment of abdomen with median third marked off from each side by a narrow impressed line. Basal joint of hind tarsi curved and almost twice the length of the others combined. Length, 3.25 mm.

Hab.—Queensland: Kuranda (G. E. Bryant).

Somewhat like *M. brevis*, but elytra scarcely as wide, although wider than in most of the allied species, and basal joint of hind tarsi longer. On each of the

two specimens before me the elytra appear to have a large infuscation posteriorly, but this is due to the black of the wings showing through, they are without faint traces of striation, as on some of the allied species

MONOLEPTA INTEGRICOLLIS, n.sp

Pale flavous, eight apical joints of antennae partly or entirely infuscated or blackish, extreme base of hind tarsi black

Head with interocular groove bisinuate Eyes large and prominent Antennae long and thin, second and third joints almost equal, their combined length slightly more than fourth Prothorax strongly convex, sides gently rounded, punctures dense, sharply defined and not rugose Elytra widest slightly beyond the middle, punctures on basal half slightly larger than on prothorax and sharply defined, even to apex, epipleurae suddenly terminated almost level with hind coxae, their inner margins very feebly infuscated Basal joint of hind tarsi almost twice as long as the rest combined Length, 3 mm

Hab—Queensland Cairns district (F P Dodd)

Differs from the preceding species in being paler, more evenly convex, prothorax not at all rugose and elytral epipleurae with margins scarcely infuscated, the general appearance and the hind tarsi are much as in *M. dilutor*, but the prothorax is without traces of a transverse median impression

MONOLEPTA CRIBROSA, n.sp

Of a rather dingy flavous, mesosternum, metasternum and inner margins of elytral epipleurae black, antennae infuscated, except for parts of three basal joints

Head with interocular groove feebly curved Eyes large and prominent Antennae thin, third joint distinctly longer than second, and about two-thirds the length of fourth Prothorax transversely suboblong, somewhat flattened in middle, without traces of transverse median impression, punctures dense, sharply defined and comparatively coarse Elytra almost parallel-sided, with punctures much as on prothorax, epipleurae extremely narrow beyond hind coxae Basal joint of hind tarsi slightly longer than the rest combined Length, 2.25 mm

Hab—Queensland Cairns district (A M Lea)

A small, narrow, pale species with unusually coarse punctures, those even about apex of elytra being larger than on most species towards the base, about the sides of elytra they are subseriately arranged, although not in striae The hind tarsi are not black at the extreme base The type is a male, and the apex of its abdomen is somewhat distorted, but this may be partly due to postmortem contractions

MONOLEPTA INCISIVENTRIS, n.sp

♂—Pale castaneo-flavous, elytra and legs still paler, the former with the suture and the inner margins of the epipleurae very narrowly blackish, scutellum, metasternum and abdomen blackish, three basal joints of antennae pale, the others more or less deeply infuscated or blackish

Head with interocular groove arched slightly forwards, a short deep impression in front of its middle Eyes (for the genus) not very large Antennae long and thin, third joint slightly longer than second, their combined length slightly more than fourth Prothorax about twice as wide as long, sides gently curved, hind angles slightly armed, punctures somewhat rugose and not very large but rather sharply defined Elytra rather elongate, parallel-sided to near apex, punctures

rather dense and sharply defined, becoming smaller posteriorly, where they are about as large as those on prothorax, epipleurae scarcely traceable beyond hind coxae. Tip of abdomen triangularly notched. Basal joint of hind tarsi about the length of the rest combined, its base not dark. Length, 3.3-2.5 mm.

♀ — Differs in having somewhat smaller eyes and shorter antennae, and tip of abdomen not notched.

Hab — Tasmania. Waratah, Wilmot (H. J. Carter and A. M. Lea), Denison Gorge (Aug. Simson).

Fairly close to *M. sordidula*, but narrower, elytra almost lemon-yellow, with more sharply defined punctures and most of under surface constantly blackish, the prothorax is without remnants of a transverse median impression, so the species cannot be *M. interincta*. On several specimens the pronotum is faintly mottled, but this is probably due to postmortem decomposition.

MONOLEPTA ALBIPENNIS, n. sp.

Pale castaneo-flavous, elytra almost white, suture, extreme margins and epipleurae infuscated, mesosternum, metasternum, abdomen, femora (except knees) and antennae (except three basal joints, which are obscurely reddish) black or blackish.

Head with interocular groove rather deep and almost straight, a subtriangular depression in front of its middle. Eyes not very large. Antennae long and thin, second and third joints combined shorter than fourth. Prothorax not twice as wide as long, sides moderately rounded, base narrower than apex, hind angles slightly armed, without remnants of transverse median depression, punctures small, sparse and ill-defined in middle, more distinct, but still feeble, on sides. Elytra rather thin and parallel-sided to near apex, punctures small and ill-defined, epipleurae narrow, even at base. Basal joint of hind tarsi almost as long as the rest combined, its extreme base not dark. Length, 3.3-3.5 mm.

Hab — Western Australia. Ankertell (H. W. Brown), Beverley (F. H. du Boulay).

The outlines are somewhat as in the preceding species, but the whole insect is less convex, the elytra are almost white, the punctures are much less conspicuous, and the femora are partly black. The scutellum is of a rather dingy red, but from some directions appears almost black.

MONOLEPTA DEPRESSA, n. sp.

Very pale castaneo-flavous, elytra tinged with yellow, suture (very narrowly), tip of abdomen, palpi and tarsi more or less infuscated; antennae blackish, from one to four joints partly reddish.

Head with interocular groove moderately arched forwards, a short deep groove in front of its middle. Eyes not very large. Antennae long and thin, third joint longer than second, their combined length distinctly more than fourth. Prothorax with outlines and punctures as described in preceding species, elytra much the same but punctures more sharply defined although very small, epipleurae scarcely traceable beyond hind coxae, their inner margins not blackish. Basal joint of hind tarsi slightly shorter than the following ones combined. Length, 3.5 mm.

Hab — Western Australia. Cue (H. W. Brown).

A pale, depressed species, with the general outlines of the preceding one, but sterna, most of abdomen and femora pale, and joint three of antennae decidedly longer, the third joint although distinctly shorter than the first or fourth, is not-

ably longer than is usual in the genus, the absence of a transverse median impression from the pronotum distinguishes it from *M. subsecuralis*. On the type, probably a male, the fifth segment of abdomen has a distinct median impression, and the antennae are longer, with more of the joints pale on the under surface than on a second specimen from Mr Brown. Another specimen (from Swan River, A. M. Lea) probably belongs to the species, but has less of the tarsi and more of the tip of abdomen infuscated, and two of the basal joints of its antennae are partly pale.

MONOLEPTA HYPOMELA, n.sp.

Pale castaneo-flavous, elytra flavous, suture (very narrowly) and inner margins of epipleurae infuscated, mesosternum, metasternum and abdomen black, antennae blackish, three basal joints and sometimes parts of the fourth and fifth pale, two apical joints of tarsi infuscated.

Head with interocular groove almost straight, a subtriangular impression in front of its middle. Antennae rather long and thin, third joint slightly longer and thinner than second, their combined length about equal to fourth. Prothorax not quite twice as wide as long, sides moderately rounded, hind angles feebly armed, punctures small and feeble, even on sides. Elytra not very long, widest slightly beyond the middle, with rather dense and minute but fairly sharp punctures, epipleurae scarcely traceable beyond hind coxae. Basal joint of hind tarsi almost as long as the rest combined. Length, 3.3.25 mm.

Hab—Western Australia. Beverley (F. N. du Boulay), Coolgardie (C. A. White), Swan River, Donnybrook, Boyanup, Bridgetown (A. M. Lea).

Fairly close to *M. sordidula*, but rather more robust, punctures of upper surface smaller and less rugose, and metasternum and abdomen deep black, the elytral punctures are much finer than in *M. subsecuralis*, and the prothorax is without a transverse median impression. On several specimens the scutellum is almost black, but it is usually slightly infuscated, on an occasional specimen parts of the femora and tibiae are slightly infuscated.

MONOLEPTA OBSCURIPES, n.sp., or var.

Head and prothorax pale castaneo-flavous, elytra of a rather dingy flavous, suture and margins narrowly infuscated, under surface, legs (knees and trochanters excepted) and antennae black. Length, 3 mm.

Hab—South Australia. Parashina (Natural History Expedition), Quorn (A. H. Elston).

A dingy species, with structure as described in the preceding one, of which, perhaps, it should be regarded as a variety, but the elytral punctures are slightly larger, and the legs are black, except for the knees and trochanters.

MONOLEPTA EXSANGUIS, n.sp.

Pale flavous, tip of eleventh joint of antennae and the claws slightly infuscated.

Head with interocular groove slightly curved, a subtriangular impression in front of its middle. Eyes rather small for the genus. Antennae not very long, and somewhat stouter than usual, second and third joints subequal, their combined length slightly more than first, and distinctly more than fourth. Prothorax gently and evenly convex, sides gently rounded, all angles feebly dentate, without transverse median impression; punctures scarcely traceable in middle and but little more distinct on sides. Elytra scarcely parallel-sided, with dense and minute

but rather sharply defined punctures; epipleurae not traceable beyond hind coxae. Basal joint of hind tarsi slightly shorter than the rest combined. Length, 2.75-3 mm.

Hab—Western Australia. Pinjarrah (A. M. Lea)

A minute depressed species, entirely pale except for the extreme tip of antennae, claws, tips of mandibles and eyes; the abdomen and elytra are of a slightly different shade from the other parts, on one specimen the elytra have a slight tinge of green.

Group 1 b Prothorax with distinct median transverse impression

MONOLEPTA VIGILANS, n. sp.

Flavous, extreme base of hind tarsi black, antennae with fourth to eleventh joints more or less slightly infuscated, or with the tips infuscated.

Head with interocular groove moderately arched forwards, a subtriangular impression in front of its middle. Eyes large and prominent. Antennae long but not very thin, second and third joints short and subequal, their combined length slightly less than fourth. Prothorax about twice as wide as long, sides gently rounded, hind angles feebly dentate, median transverse impression represented by a shallow remnant towards each side, punctures fairly dense, but minute and inconspicuous. Elytra subelliptic-ovate, rather long and convex, with dense and rather small, subrugose punctures, but fairly sharply defined, epipleurae very narrow at hind coxae and scarcely traceable beyond them. Basal joint of hind tarsi slightly longer than the following ones combined. Length, 3.75-4 mm.

Hab—North-Western Australia (Blackburn's collection)

In general appearance fairly close to *M. cognata*, but with stouter antennae, of which the second and third joints are shorter. The suture and epipleurae of the elytra are not infuscated, the third tarsal joint is sometimes infuscated, on one specimen the infuscation of the antennae after the third joint is so slight that they might be regarded as entirely pale. In the female the prothorax is less transverse than in the male, has slightly stronger punctures, the eyes are smaller and the antennae are somewhat shorter, those of the male extend almost to the tips of the elytra. There are a few short hairs on the sides about apex of elytra, but they appear to be easily abraded. One specimen has a large, shallow subtriangular, mediobasal impression on the pronotum, but this is probably due to postmortem contraction.

MONOLEPTA SUBVIGILANS, n. sp.

Flavous, extreme base of hind tarsi black, antennae slightly infuscated after the third or fourth joints.

Head with interocular groove almost straight, a narrow impression in front of its middle. Eyes not very large. Antennae not very thin, scarcely passing middle of elytra, second and third joints combined slightly longer than fourth. Prothorax twice as wide as long, sides gently rounded, hind angles slightly dentate; a shallow, transverse, median impression, shallowest in middle, but not entirely interrupted there; punctures small and inconspicuous. Elytra feebly dilated to beyond the middle, with dense and sharply defined punctures of moderate size, epipleurae scarcely traceable beyond hind coxae, their inner base narrowly infuscated. Basal joint of hind tarsi about once and one-fourth the length of the rest combined. Length, 3.5-4.25 mm.

Hab.—North-Western Australia: Fortescue River (W. D. Dodd)

Joints two and three of the antennae are short, but their combined length is slightly in excess of the fourth, on the preceding species their combined length is shorter than the fourth. There are three of the present species and seven of the former before me, so the differences appear to be reliable, the present species is also less convex, with smaller eyes (both sexes) shorter antennae (both sexes) and with more distinct punctures. The antennae of the male are scarcely longer than those of the female, but their middle joints are somewhat stouter, in the male the apical segment of the abdomen has a narrow longitudinal impression on each side of the median third.

MONOLEPTA PALLIDULA, n sp

Flavous, tip of eleventh joint of antennae infuscated, extreme base of hind tarsi black.

Head with interocular groove slightly arched forwards, a small depression in front of its middle. Eyes large and prominent. Antennae long and moderately thin, second and third joints combined almost the exact length of fourth. Prothorax almost twice as wide as long, sides gently rounded, hind angles rectangular, a median transverse impression, almost complete, but slightly narrowed across middle, with small and subrugose but fairly distinct punctures. Elytra not quite parallel-sided, with fairly dense and rather small, but sharply defined punctures, scarcely smaller about apex than near base, epipleurae scarcely passing hind coxae, their inner base scarcely visibly infuscated. Basal joint of hind tarsi about once and one half as long as the rest combined. Length, 3.25-3.5 mm.

Hab—Northern Territory. Groote Eylandt (N. B. Tindale).

A very pale species, structurally close to *M. cognata*, but with only the tip of the antennae infuscated. In the male the eyes are larger and the antennae longer than in the female, and the apical segment of abdomen has two longitudinal impressions. Two specimens were obtained.

MONOLEPTA PALIDUS, n sp

Flavous, antennae (except three basal joints) and extreme base of hind tarsi black.

Head with interocular groove almost straight, a narrow impression in front of its middle. Eyes large and prominent. Antennae long but not very thin, passing tips of elytra, second and third joints very short, combined scarcely more than half the length of fourth, prothorax not twice as wide as long, sides gently rounded, hind angles slightly obtuse, transverse median impression not extending to sides and interrupted in middle. Elytra not quite parallel-sided, with dense and rather small but sharply defined punctures, in places somewhat rugose, epipleurae very narrow at hind coxae, their inner basal margin not infuscated. Length, 3.5 mm.

Hab—Northern Territory. Groote Eylandt (N. B. Tindale).

At once distinguished from the preceding species and from *M. cognata* by the antennae, joints two and three are very short, their combined length being much shorter than the fourth, on *M. vigilans*, on which they are also very short, the fourth is considerably shorter than on the present species, so that the disproportion is less striking, the antennae also in general are darker than on that species. The type now is without hind tarsi, but when first examined they were noticed to be long. Type, I 15,606.

A specimen from North-Western Australia (Port George IVth, J. R. B. Love) probably belongs to this species, although it is smaller (3.25 mm) and

even paler than the type, but joints two to four of the antennae agree exactly, both specimens have the suture without the least infuscation

MONOLEPTA TROPICA, n. sp.

Pale watery flavous, antennae (except two apical joints) and extreme base of hind tarsi black

Head with interocular groove slightly curved, three small impressions in front of it. Eyes large and prominent. Antennae long and rather thin, third joint slightly longer than second, their combined length subequal to fourth. Prothorax about once and two-thirds as wide as long, sides straight to near apex, hind angles somewhat obtuse, with remnants of a wide, transverse median impression, punctures irregular but mostly small, dense, and somewhat rugose. Elytra with gently rounded sides, punctures dense and rather small, but sharply defined, epipleurae scarcely traceable beyond hind coxae. Basal joint of hind tarsi twice as long as the rest combined. Length, 4.75-5 mm.

Hab.—Northern Queensland (Blackburn's collection)

An unusually large, pale species with colours much as those of *M. fumaticornis*, but wider, elytral epipleurae not narrowly margined with black, two apical joints of antennae pale, and basal joint of hind tarsi longer. In general appearance it is evidently near *M. ingenua*, but the elytra are shining instead of sub-opaque, the punctures of the upper surface are evidently stronger, and only two apical joints of the antennae are pale.

MONOLEPTA FOVEICEPS, n. sp.

Pale flavous, inner margins of elytral epipleurae and extreme base of hind tarsi black, eight apical joints of antennae each infuscated at apex.

Head with interocular groove foveate in middle, the lateral portions very short. Eyes large. Antennae long and thin, combined length of second and third joints almost equal to fourth. Prothorax about once and one half as wide as long, sides straight to near apex, hind angles somewhat obtuse, with fairly large remnants of a transverse median impression, punctures rather dense and sharply defined. Elytra with sides slightly rounded, punctures much as on prothorax, epipleurae scarcely traceable beyond hind coxae. Basal joint of hind tarsi twice as long as the rest combined. Length, 3 mm.

Hab.—Queensland. Cairns district (F. P. Dodd)

The distinctive feature of this species is the interocular fovea, this is due to the interocular groove having an enlargement behind in addition to the more or less triangular impression, that on most species opens out from the middle of its front, the fovea readily distinguishes the species from *M. cognata* (whose eyes are also smaller). *M. fumaticornis*, *M. subvigilans*, *M. vigilans*, *M. tropica*, and other pallid species of much the same size.

Two males from Bundaberg (Blackburn's collection) probably belong to the species, but are larger (3.5 mm) and one of them has about one-eighth of the suture at the apex very narrowly black, on the type a much smaller portion is only infuscated; the other specimen has the suture and epipleurae entirely pale, but the three basal joints of antennae partly infuscated and the others deep black.

MONOLEPTA ALBA, n. sp.

Pale flavous, almost white, tip of antennae and inner margin of elytral epipleurae infuscated, extreme base of hind tarsi black.

Head with interocular groove slightly curved and thin, impression in front of its middle thin. Eyes rather large. Antennae long and thin, third joint slightly longer than second, their combined length slightly less than fourth. Prothorax about twice as wide as the length of the sides, these quite straight almost to apex; with slight remnants of a median transverse impression; punctures small but rather well defined. Elytra with sides not quite parallel, punctures dense and not very large, but sharply defined throughout, epipleurae scarcely traceable beyond the hind coxae. Basal joint of hind tarsi fully twice as long as the rest combined. Length, 3.25 mm.

Hab—Queensland Thursday Island (N. B. Tindale)

The upper surface is subopaque, and thus, combined with sharply defined elytral punctures, unusually pale antennae and long basal joint of hind tarsi, readily distinguishes the species from the other pallid ones with transverse impression of prothorax, and suture not infuscated. *M. fumaticornis*, from the same island, is a larger, polished species, with deep black antennae.

MONOLEPTA NITIDA, n. sp.

Pale flavous, tip of antennae infuscated, extreme base of hind tarsi black.

Head with interocular groove feebly curved, a slight impression in front of its middle. Eyes rather large. Antennae rather long and thin, third joint slightly longer than second, their combined length more than fourth. Prothorax almost twice as wide as long, sides almost straight, hind angles slightly dentate, median transverse impression interrupted in middle, or at least enfeebled there; punctures fairly dense and small, but sharply defined. Elytra subelliptic, punctures slightly larger than on prothorax and usually well-defined but somewhat rugose; epipleurae very narrow at hind coxae, but traceable beyond them, their inner margins very faintly infuscated. Basal joint of hind tarsi almost twice as long as the rest combined. Length, 3.25-3.5 mm.

Hab—Queensland Brisbane (Dr. A. J. Turner), Gympie.

Close to the preceding species, but with upper surface shining and elytral punctures not so sharply defined. A male from Bundaberg (Blackburn's collection) that apparently belongs to the species has the tips of six apical joints of antennae infuscated; on the type male only the tip of the eleventh is infuscated, and that but slightly. Another male from Cairns (A. M. Lea) that probably also belongs to the species, has the tips of four apical joints of the antennae infuscated, and the inner base of the elytral epipleurae black.

MONOLEPTA METASTERNALIS, n. sp., or var. of COGNATA.

Pale flavous, metasternum, inner basal margin of elytral epipleurae, extreme base of hind tarsi and most of antennae black.

Head with interocular groove slightly curved, a small depression in front of its middle. Eyes rather large. Antennae long and thin, third joint slightly longer than second, their combined length slightly greater than fourth. Prothorax fully twice as wide as long, sides straight; transverse impression enfeebled but not completely interrupted in middle, punctures rather small but sharply defined, and dense in most parts. Elytra feebly dilated to beyond the middle; punctures somewhat larger and more distinct than on prothorax, epipleurae scarcely traceable beyond hind coxae. Basal joint of hind tarsi almost twice as long as the rest combined. Length, 3.25-3.5 mm.

Hab—Queensland Mount Tambourine (A. M. Lea).

In general appearance very close to *M. cognata* (of which it should possibly be regarded as a variety) but metasternum blackish, basal joint of hind tarsi longer, and punctures of upper surface coarser. The elytra are of a slightly paler shade than the rest of the upper surface, on one specimen they are almost white, the eight apical joints of antennae are black or blackish, the three basal joints are paler, but of these the second is slightly but distinctly darker than the first or third. Of three specimens from the mountain two have the metasternum deep black and one of these has parts of the abdomen obscurely infuscated, the third has the metasternum pale but the abdomen partly infuscated.

MONOLEPTA FLAVOANGUSTA, n. sp.

Pale orange-flavous, parts of tarsi infuscated.

Head with interocular groove slightly arched forwards, impression in front of its middle feeble. Eyes, for the genus, rather small. Antennae rather long and thin, third joint slightly longer than second, their combined length just perceptibly greater than fourth. Prothorax not twice as wide as long, sides gently arcuate near base, median transverse impression fairly deep, but interrupted in middle, punctures minute and inconspicuous. Elytra almost parallel-sided, with dense and rather sharply defined but small punctures, becoming somewhat smaller and more rugose posteriorly, epipleurae very narrow beyond hind coxae. Basal joint of hind tarsi about once and one-fourth the length of the rest combined. Length, 3 mm.

Hab.—Queensland. Bowen (Aug. Simson 74/3549).

Smaller and less convex than *M. munda* and *M. alba*, more shining and hind tarsi infuscated. On both specimens before me the claw-joint of the front tarsi, three apical joints of middle tarsi, and the entire hind ones are infuscated, with the extreme base of the latter black, the antennae and elytral epipleurae are entirely pale. There are some thin upright setae or short hairs on the elytra, but they appear to be easily abraded. On one specimen there are numerous small irregular black spots, I have seen similar spots on other specimens of the genus, and believe they represent punctures by predaceous insects.

MONOLEPTA OETHODOXA, n. sp.

Flavous; suture narrowly infuscated or blackish, extreme base of hind tarsi black, two apical joints of tarsi, most of antennae and inner margins of elytral epipleurae more or less infuscated.

Head with interocular groove rather deep and slightly curved, a small subtriangular impression in front of its middle. Eyes large. Antennae with second and third joints subequal, their combined length slightly more than fourth. Prothorax distinctly less than twice as wide as long, sides gently rounded, hind angles feebly dentate; transverse impression rather feeble and traceable across middle; punctures rather dense, small and somewhat rugose. Elytra subelliptic, with dense and rather small but sharply defined punctures, epipleurae very narrow at hind coxae. Basal joint of hind tarsi about once and one half the length of the rest combined. Length, 3.5-3.75 mm.

Hab.—Northern Territory: Groote Eylandt (N. B. Tindale).

An ordinary looking species, much like *M. suturalis*, but elytra with smaller punctures, sutural infuscation very narrow and vanishing posteriorly, prothorax with smaller punctures, and transverse impression more feeble; *M. foveiventris* has shorter epipleurae, and transverse impression of prothorax continuous across

middle. The antennae are mostly black or blackish, the three basal joints are usually pale (the tip of the second is generally infuscated) and parts of the fourth and sometimes of the fifth and sixth, on one specimen the sterna and abdomen are rather deeply infuscated, on two others they are somewhat darker than the upper surface but not infuscated, and on one the metasternum is infuscated along the middle, but on five others the under surface is no darker than the elytra, both edges of the elytral epipleurae are narrowly infuscated about the base, and on specimens with under surface partly dark the infuscation can be traced to beyond the middle. The female has smaller eyes and prothorax than the male, shorter antennae and legs, and apical segment of abdomen without longitudinal impressions. A specimen from Melville Island (W D Dodd) may belong to the species, but has smaller and more depressed eyes, although these have the appearance of having collapsed.

MONOLEPTA BASICEPS, n.sp.

Flavous, elytra almost white, basal fourth of suture and base near scutellum rather narrowly infuscated, suture elsewhere very narrowly and scarcely visibly infuscated, head deep black behind interocular groove, most of antennae, metasternum and parts of tarsi infuscated.

Head with interocular groove deep and almost straight, a small impression in front of its middle, a feeble line from its middle almost to base. Antennae, for the genus, not very thin, second and third joints very short, combined slightly shorter than fourth, the latter rather stout, the following joints slightly decreasing in width, but not in length, eleventh longer. Prothorax less transverse than is usual in genus, sides gently rounded, median transverse impression distinct but interrupted in middle, punctures very minute and inconspicuous. Elytra parallel-sided to near apex, punctures dense but small and rugose, epipleurae very narrow at hind coxae, their inner margin scarcely visibly infuscated. Basal joint of hind tarsi slightly shorter than the rest combined. Length, 3 mm.

Hab—Northern Territory. Groote Eylandt (N B Tindale).

Distinguished from other pale species with suture infuscated by the black base of head, and comparatively short basal joint of hind tarsi, *M. froggatti*, whose head is partly dark, has longer and thinner antennae, longer hind tarsi, smaller eyes and more of elytra infuscated. The three basal joints of antennae are coloured as the pronotum, and shining, the others gradually become darker till the apical one is almost black. There is a longitudinal impression on each side of the median third of the apical segment of abdomen, so the only specimen obtained is a male.

MONOLEPTA ALBINERVOSA, n.sp.

♂—Flavous, prothorax slightly paler than head and darker than elytra, antennae (first and sometimes parts of second and third joints excepted), metasternum, abdomen and most of tarsi infuscated.

Head with interocular groove moderately curved, a small impression in front of its middle. Eyes moderately large. Antennae extending almost to apex of abdomen, second and third joints very short, their combined length distinctly less than fourth. Prothorax less transverse and sides more strongly rounded than usual in the genus, hind angles feebly dentate, transverse median excavation shallow and widely interrupted in middle; punctures dense, minute and slightly rugose. Elytra almost parallel-sided to near apex; punctures dense, not very small and somewhat rugose, the derm generally also slightly wrinkled; epipleurae

narrowly traceable beyond hind coxae, inner basal margins very narrowly black. Basal joint of hind tarsi slightly longer than the rest combined, its extreme base black. Length, 4.5-5 mm.

♀—Differs in having the head and eyes smaller, antennae scarcely passing basal segment of abdomen, their second and third joints combined but slightly shorter than fourth, prothorax longer (scarcely once and one-fourth as wide as long), sides less rounded, and apical segment of abdomen simple.

Hab—South Australia. Cooper's Creek (South Australian Museum Expedition of 1916).

In general appearance near *M. tarsalis*, but cannot be that species, as the basal joint of the hind tarsi is not greatly dilated (on the only male before me (its sex is distinct by two longitudinal impressions on the apical segment of abdomen), it is about the size of the species identified by Blackburn as *M. suturalis*, but the elytra are still paler with the sutural infuscation still narrower, and third joint of antennae different, *M. cognata* is a smaller species with basal joint of antennae darker and transverse impression of pronotum deeper, *M. froggatti* and *M. subsuturalis* are smaller and otherwise different. At first glance the antennae, except for the basal joints, appear to be evenly infuscated throughout, but on close examination the tip of each joint may be seen to be darker (usually black) than the rest of it, the scutellum is usually infuscated, the infuscation of the suture is extremely narrow and faint, and could be easily overlooked, on several specimens two very thin whitish venational lines may be traced on each elytron from base to near apex, and similar lines may sometimes be traced on specimens of other pale species; on five females the metasternum and abdomen are more or less deeply infuscated throughout, but on a sixth the under surface is pale except for a slight infuscation of the metasternum and parts of sides of abdomen, the extent and degree of tarsal infuscation varies. From some directions the head appears to have a very faint median line from the interocular groove to the base, on specimens with the extreme base of head exposed this is seen to be somewhat blackish.

MONOLEPTA FOVLIVENTRIS, n. sp.

Flavous, elytra slightly paler than prothorax but with suture very narrowly infuscated, metasternum, abdomen and extreme base of hind tarsi black, antennae (three basal joints and parts of the two following ones pale), scutellum and claw joints more or less deeply infuscated.

Head with interocular groove slightly curved, a subtriangular impression in front of its middle. Eyes not very large. Antennae thin and moderately long, third joint slightly longer than second, their combined length slightly greater than fourth. Prothorax fully twice as wide as long, sides straight to near apex, hind angles rectangular; transverse median impression distinct, seldom interrupted in middle, but usually enfeebled there, punctures mostly minute and inconspicuous. Elytra not quite parallel-sided to near apex, with dense and small but sharply defined punctures, epipleurae very narrow at hind coxae, inner margin narrowly infuscated or black. Basal joint of hind tarsi about as long as the rest combined. Length, 3.75-4.5 mm.

Hab—South Australia. Parashilna (Natural History Expedition and H. M. Hale).

In general appearance close to the preceding species, but consistently smaller, less convex, prothorax more transverse, and fifth segment of abdomen foveate in both sexes, on one sex (presumably the male) the fifth segment has a median im-

pression from apex to base, on the other it appears as an apical fovea. The basal joint of hind tarsi not specially inflated in male distinguishes from description of *M tarsalis*, from the species identified by Blackburn as *M suturalis* it differs in being smaller and sutural infuscation much narrower and fainter, *M froggatti* has sutural infuscation wider and head partly black, *M cognata* is a slightly wider species, with decidedly larger eyes, basal joints of antennae darker, and basal joint of hind tarsi longer in proportion.

MONOLEPTA CRIBRICEPS, n. sp.

Pale watery flavous, a median line on basal half of head antennae (four, five or six basal joints partly pale), palpi, scutellum, suture (very narrowly), sterna (flanks of prosternum excepted), abdomen, one or two apical joints of each tarsus, and extreme base of hind tarsi infuscated or black.

Head with interocular groove straight, a small impression in front of its middle, dense punctures behind it. Eyes rather large. Antennae long and thin, third joint slightly longer than second, their combined length slightly shorter than fourth. Prothorax twice as wide as long, sides gently rounded, hind angles rectangular, median transverse impression distinct, but usually somewhat enfeebled in middle, punctures dense and somewhat rugose, but mostly sharply defined. Elytra subparallel-sided to near apex, with dense, sharply defined punctures, slightly larger than on prothorax, epipleurae very narrow at hind coxae, with a slight median infuscation in addition to a narrow black inner margin. Basal joint of hind tarsi almost the exact length of the rest combined. Length, 4.4-5 mm.

Hab—Tasmania. Strahan (H. J. Carter and A. M. Lea), Mole Creek (A. M. Lea).

An unusually pale species, and one of the few in which the head is conspicuously punctate and with an infuscated median line. The male differs from the female in having smaller eyes, shorter antennae and fifth segment of abdomen without longitudinal impressions. Two extremely thin, white, venational lines may sometimes be seen on each elytron, as on some specimens of *M albinervosa*.

MONOLEPTA TASMANIENSIS, n. sp.

Black, pronotum, elytra and flanks of prosternum pale flavous.

Head with a narrow, deep, slightly curved interocular groove, a subtriangular impression in front of its middle. Eyes rather small. Antennae moderately long and thin, second and third joints subequal in length, combined almost equal to fourth. Prothorax not twice as wide as long, sides almost straight, hind angles subdentate, median transverse impression distinct but interrupted, or at least enfeebled in middle, punctures small irregular and rugose, but in places sharply defined. Elytra subparallel-sided to near apex; with dense, sharply defined punctures, mostly larger than on prothorax, but in parts rugose, epipleurae distinct to about second segment of abdomen, inner margins infuscated. Basal joint of hind tarsi scarcely longer than the rest combined. Length, 3.75-4 mm.

Hab—Tasmania. Waratah and Strahan (H. J. Carter and A. M. Lea).

The entirely black head (except that parts of the mouth are obscurely diluted with red) is unusual in a species with pale prothorax and elytra, on several specimens parts of the elytra are transparent, allowing white venational lines and the black wings to be clearly seen; the suture is very narrowly darker than the adjacent parts, but it could hardly be regarded as infuscated. The female

differs from the male in the eyes being slightly smaller, antennae slightly shorter, and fifth segment of abdomen without two longitudinal impressions

Five specimens from Cradle Mountain (Carter and Lea) probably represent a variety of this species, they agree in structure with it, but have the pronotum elytra and flanks of prosternum more brightly flavous, not at all transparent, the suture narrowly blackish, and the pronotum with five feebly infuscated spots, of which four form a semicircle in front of a small mediobasal one

MONOLEPTA PACHYCERA, n.sp

♂—Flavous, head and prothorax with an orange tinge, metasternum, abdomen and extreme base of hind tarsi black, antennae infuscated or blackish, parts of five or six joints pale, claw joints deeply infuscated

Head moderately large, interocular groove deep in middle, feeble at sides, a very minute impression in front of its middle. Eyes comparatively small. Antennae moderately long, much stouter than usual, third joint slightly longer than second, their combined length greater than fourth, the latter thickest of all, the others gradually decreasing in width but even the eleventh moderately stout. Prothorax fully twice as wide as long, sides comparatively strongly rounded, hind angles feebly dentate, median transverse impression rather wide, but interrupted in middle, punctures minute and inconspicuous. Elytra comparatively short, slightly dilated to beyond the middle, with dense and small, but sharply defined punctures, epipleurae not very narrow, but scarcely traceable beyond first abdominal segment. Basal joint of hind tarsi about as long as the rest combined. Length, 3.25-4 mm.

♀—Differs in having antennae much thinner, the infuscation less pronounced, metasternum infuscated only, abdomen only dark at apex and in the fifth segment of abdomen

Hab—South Australia. Mount Lofty (S. H. Curnow, A. H. Elston and R. F. Kemp), Quorn (Elston)

The antennae of the female are fairly stout, but those of the male are stouter than those of any other species before me. The outer margins of the elytra of the male, including the epipleural margins, are narrowly infuscated, but in the female only the inner margins of the epipleurae are infuscated, the scutellum is usually infuscated on the male, usually pale on the female; on several females four or five of the basal joints of antennae are entirely pale. On several specimens two very narrow white venational lines may be seen on each elytron.

MONOLEPTA MIMETES, n.sp

Bright flavous, elytra paler than prothorax but with the suture and margins narrowly infuscated or black, scutellum, metasternum, abdomen and extreme base of hind tarsi black, three basal joints of antennae pale, the others partly or entirely infuscated.

Head with interocular groove gently curved, a short impression in front of its middle, behind it with numerous small sharply defined punctures. Antennae stout (especially in male), second and third joints of equal length, combined equal to fourth. Prothorax almost twice as wide as long, sides comparatively strongly rounded, hind angles slightly dentate; median transverse impression distinct, interrupted or enfeebled in middle, punctures dense and minute. Elytra almost parallel-sided to near apex; with dense, small, and slightly rugose punctures; epipleurae very narrow at hind coxae, all margins infuscated. Basal joint of hind coxae as long as the rest combined. Length, 3 mm.

Hab—Western Australia Cue (H W Brown)

The antennae of the male are considerably stouter than those of *M. abundans*, and almost as stout as those of the preceding species, from the latter it is also distinguished by its narrower form, dark suture and margins of elytra, by the stronger punctures of head and smaller ones of elytra, it is like rather large *M. subsuturalis*, but the elytral punctures are smaller (this is especially evident from the sides) and antennae stouter, those of the female being stouter than those of the male of that species. In some lights the elytra have a faint greenish gloss. The female differs from the male in having the head slightly smaller, antennae decidedly thinner and apical segment of abdomen without a longitudinal impression on each side of the median third. The type male has most of the legs damaged or missing, his antennae also are damaged, three of the terminal joints being missing, but the fourth to eighth joints are of about equal size.

MONOLEPTA ANGUSTIFUSCA, n.sp.

♂—Pale flavous, head slightly darker than elytra, metasternum, abdomen, tips of four or five apical joints of antennae, claw-joints and extreme base of hind tarsi more or less deeply infuscated or blackish.

Head with interocular groove rather shallow and almost straight, a feeble impression in front of its middle, scarcely visible punctures behind it. Eyes not very large. Antennae long and thin, second and third joints subequal, their combined length slightly less than fourth. Prothorax not twice as wide as long, sides straight to near apex, hind angles slightly dentate; median transverse impression rather wide and shallow, becoming shallower in middle, with rather dense and minute punctures on sides, less distinct elsewhere. Elytra rather narrow, parallel-sided to near apex, with dense and small but sharply defined punctures, epipleurae very narrow, scarcely passing hind coxae, inner margins narrowly infuscated. Fifth segment of abdomen with a longitudinal impression on each side of the medio-apical third. Basal joint of hind tarsi scarcely longer than the rest combined. Length, 2.75 mm.

Hab—Western Australia Cue (H W Brown)

The antennae are somewhat stouter and paler than on *M. foveiventris*, and the second and third joints are shorter than the fourth, instead of longer, the preceding species has much stouter antennae in the male. The sutural infuscation is distinct, but narrow and not very dark.

MONOLEPTA ABUNDANS, n.sp.

Flavous, in parts more or less deeply infuscated or blackish.

Head with interocular groove straight, a small subtriangular impression in front of its middle, a very feeble one behind its middle, with minute but rather sharp punctures towards base. Eyes not very large. Antennae long and thin, second joint just shorter than third, their combined length slightly less than fourth. Prothorax twice as wide as long, sides gently rounded, hind angles feebly dentate, median transverse impression rather wide and shallow, somewhat enfeebled in middle, punctures minute. Elytra with sides feebly dilated to beyond the middle, punctures dense, small and slightly rugose, epipleurae very narrow at hind coxae. Basal joint of hind tarsi just perceptibly longer than the rest combined. Length, 2.25-3 mm.

Hab—South Australia: Mount Lofty Ranges (S. H. Curnow, A. H. Elston and J. G. O. Tepper), Adelaide (Tepper), Parachilna (H. M. Hale), Kangaroo Island (A. M. Lea).

A small and rather dingy species, *M. inconspicua* is slightly wider, with paler antennae and legs and transverse impression of prothorax faint or absent; *M. tricolor* is slightly larger, with decidedly stronger punctures, femora entirely pale and suture much darker (usually black), *M. sordidula* is without median impression on prothorax, and with sharply defined and larger punctures; *M. sub-suturalis* is paler, with coarser elytral punctures. The head and prothorax are rather brightly flavous, the elytra are paler, with the suture narrowly infuscated at the base, the infuscation gradually dilated posteriorly and joining in with an apical one, the outer margins are also narrowly infuscated, occasionally the elytra, except the shoulders, are entirely dusky, the antennae usually have three basal joints pale, but the fourth is also sometimes partly pale, occasionally all are dark, the legs appear to have the knees and trochanters always pale, the other parts being more or less dark, occasionally the front femora and tibiae are entirely pale, the metasternum and abdomen are usually deep black, the scutellum is usually infuscated. The female differs from the male in having the head and eyes slightly smaller, antennae slightly shorter and thinner, and fifth segment of abdomen without two longitudinal impressions.

Var. Fourteen specimens from Port Lincoln probably represent a variety of the species, they differ in having the elytra with the suture narrowly infuscated throughout, the tips and sides not infuscated (except for the inner margins of the epipleurae) and femora and tibiae entirely pale, except that the apical half of the hind tibiae is sometimes dark.

MONOLEPTA PHANOPHILA, n. sp.

Pale flavous, five or six apical joints of antennae partly or entirely infuscated.

Head with interocular groove almost straight, a feeble impression in front of its middle. Antennae rather long and moderately thin, third joint distinctly longer than second and slightly shorter than fourth. Prothorax twice as wide as long, sides slightly rounded, median transverse impression feeble towards sides, widely interrupted in middle, punctures dense but very minute. Elytra not very long, sides not quite parallel, with dense and small but rather sharply defined punctures, epipleurae very narrow at hind coxae, their inner margins slightly infuscated. Basal joint of hind tarsi about one-fourth longer than the rest combined, its extreme base blackish. Length, 2.2-2.5 mm.

Hab.—Queensland: Gayndah, Rockhampton (A. M. Lea), Cairns (E. Allen), Northern Territory: Roper River (N. B. Tindale).

An unusually small, pale species, of which most of the specimens under examination were obtained at lights, the third joint of the antennae is longer in proportion than on most species of the genus. On two specimens the metasternum and abdomen are infuscated, on three others the abdomen only, on another the metasternum only, whilst on six more the under surface is entirely pale.

MONOLEPTA INDISTINCTA, n. sp.

Pale watery flavous, four or five apical joints of antennae partly infuscated.

Head with interocular groove almost straight, a small triangular impression in front of its middle. Eyes rather large. Antennae rather long and thin, second and third joints subequal, their combined length not more than fourth. Prothorax almost twice as wide as long, sides gently rounded, hind angles feebly dentate, median transverse impression rather shallow, enfeebled or interrupted in middle; punctures dense and small. Elytra with sides gently rounded, punctures dense and small and somewhat rugose; epipleurae very narrow at hind coxae, their inner

margins faintly infuscated Basal joint of hind tarsi about one-fourth longer than the rest combined, its extreme base black Length, 3 mm

Hab—Northern Territory: Groote Eylandt (N. B. Tindale)

Slightly larger than *M. phanophila*, third joint of antennae distinctly shorter in proportion, and punctures slightly stronger Four specimens were obtained

MONOLEPTA STENOCCERA, n.sp

Pale dingy flavous, each side of elytra faintly infuscated, a faintly infuscated elongated spot on each elytron, abdomen and most joints of antennae infuscated.

Head with interocular groove slightly curved, a foveate expansion at its middle Eyes comparatively small Antennae very long and thin, third joint slightly longer than second, their combined length slightly greater than fourth Prothorax not twice as wide as long, sides gently rounded, median transverse impression shallow, widely interrupted in middle, punctures small but rather sharply defined Elytra with very minute punctures; epipleurae narrow, their inner basal margins very narrowly black Basal joint of hind tarsi slightly longer than the rest combined, its extreme base not very dark Length, 2.2-2.5 mm

Hab—Western Australia Swan River, Mount Barker (A. M. Lea)

A small dingy species, with elytra apparently as fragile as those of the following species, from which it differs in having longer and decidedly thinner antennae (these pass the tips of the elytra), longer basal joint of hind tarsi, smaller punctures, and faint infuscations on prothorax and elytra, these infuscations are so slight, although alike on both specimens under examination, that the species could not fairly be referred to a group noted as having distinct markings On both specimens the elytra are twisted so that their outlines cannot be seen properly, the one from Mount Barker has the hind tibiae slightly infuscated

MONOLEPTA FRAGILIS, n.sp

Pale watery flavous, head somewhat darker than rest of upper surface, metasternum and usually the abdomen infuscated, three or four basal joints of antennae pale, the others more or less deeply infuscated, usually two apical joints of tarsi infuscated, extreme base of hind tarsi black

Head with interocular groove almost straight, a subtriangular impression in front of its middle Eyes rather small Antennae rather long and thin, second and third joints combined slightly longer than fourth. Prothorax not twice as wide as long, sides gently rounded, median transverse impression distinct but interrupted in middle, punctures in most parts dense and small, but sharply defined Elytra with dense punctures, larger than on prothorax, and many rugose; epipleurae scarcely traceable beyond hind coxae, inner margins narrowly infuscated Basal joint of hind tarsi just perceptibly longer than the rest combined Length, 2.25-2.5 mm

Hab—Western Australia Pinjarrah (A. M. Lea)

A pale dingy species, whose elytra are less rigid than usual; as a result on the insects drying up they curl irregularly, as do those of many small Malacodermidæ, the transverse impressions on the prothorax are also considerably deepened on some specimens by irregular postmortem contractions The species is narrower, paler and more fragile than *M. inconspicua*, and the prothorax is always transversely impressed Numerous specimens were obtained by means of the sweep-net

*Group 2 Prothorax entirely pale, elytra entirely dark**MONOLEPTA ANTENNALIS*, n sp

♂—Deep metallic blue, some specimens with a greenish, others with a purplish gloss, prothorax flavous, antennae and legs black, in parts with a faint metallic gloss, coxae and knees more or less reddish

Head with interocular groove slightly curved, a small triangular impression in front of its middle, some fine strigosity touching its hind edge. Eyes large and prominent. Antennae long and rather thin, third joint slightly longer than second, their combined length greater than fourth. Prothorax not twice as wide as long, sides gently curved, hind angles subdentate; median transverse impression fairly deep towards sides, enfeebled in middle, punctures minute, inconspicuous, and irregularly distributed. Elytra very feebly dilated to beyond the middle; with dense and small but sharply defined punctures, epipleurae very narrow at hind coxae. Apical segment of abdomen with a narrow deep impression, extending half way to base from each side of the medio-apical third. Basal joint of hind tarsi slightly longer than the rest combined. Length, 4.5–5 mm.

♀—Differs in having the head and eyes smaller, antennae and legs shorter and thinner, and apical segment feebly transversely impressed and without longitudinal impressions.

Hab—Northern Territory: Groote, Woodah and Connexion Islands (N. B. Tindale).

In general appearance like *M. benailae* on a greatly enlarged scale. The metasternum and abdomen are not as bright as the elytra, but the metallic gloss is conspicuous, the normally concealed base of head is reddish and on some specimens the front half of the head is in parts obscurely diluted with red, on some specimens also the suture near the base is narrowly and obscurely reddish, the scutellum is usually black, with the base pale. There are a few minute upright setae scattered about on the elytra, but they are so sparse and inconspicuous, being visible only from the sides, that the elytra could not fairly be regarded as pubescent. On many specimens, usually males, the antennae appear to be twelve-jointed, as there is a narrow circular constriction near the apex of the eleventh joint, giving the appearance of a small supplementary one, in fact it is possible that some males really have twelve-jointed antennae. Twenty-three specimens were obtained.

MONOLEPTA MONOBIA, n sp

Flavous and black

Head with interocular groove gently curved, a small depression in front of its middle. Eyes not very large. Antennae moderately long and not very thin, third joint slightly longer than second, the two combined slightly more than fourth. Prothorax not twice as wide as long, sides moderately rounded, hind angles slightly more than right angles; median transverse impression absent or almost so, punctures very minute. Elytra parallel-sided to near apex, with small, sharply defined punctures, and very minute ones, becoming still smaller posteriorly; epipleurae very narrow beyond hind coxae. Basal joint of hind coxae equal in length to the rest combined. Length, 4–7.5 mm.

Hab.—Northern Territory: Groote Eylandt (N. B. Tindale).

About the size of the preceding species, but head and legs pale, prothorax without distinct transverse impression, etc. The black parts are the elytra, metasternum, abdomen and antennae (except the three basal joints), some of the mouth parts and the tarsi are infuscated. Only one specimen was obtained.

MONOLEPTA PALLIDICOLLIS, n sp

Very dark purple (almost black), prothorax and legs flavous, the tarsi infuscated, antennae black, parts of three basal joints obscurely reddish

Head with interocular groove moderately curved, a small impression in front of its middle. Antennae rather long and thin, third joint slightly longer than 2nd, their combined length just greater than 4th. Prothorax less than twice as wide as long, sides moderately rounded, hind angles slightly obtuse, median transverse impression shallow towards sides, widely interrupted in middle, punctures minute. Elytra with dense and small but sharply defined punctures on basal half, becoming smaller posteriorly, epipleurae very narrow beyond hind coxae. Basal joint of hind tarsi as long as the rest combined, its extreme base black. Length, 4 mm

Hab — Queensland Cairns (H Hacker, No 55)

About the size and sculpture of *M antennalis*, but elytra less conspicuously blue (in most lights they appear black) and legs mostly pale, it is somewhat like *M modesta* on a large scale

MONOLEPTA MINUSCULA, n sp

Black, prothorax and legs flavous, tarsi and usually apical half or less, of tibiae infuscated, parts of three basal joints of antennae obscurely pale

Head with interocular groove rather deep and gently curved, a small impression in front of its middle. Eyes very prominent but not very large. Antennae rather long and thin, third joint slightly longer than second, their combined length slightly more than fourth. Prothorax about twice as wide as long, greatest width near apex, hind angles subdentate, median transverse impression rather wide and deep, usually slightly enfeebled in middle, punctures minute and inconspicuous. Elytra almost parallel-sided to near apex, with small and minute punctures. Basal joint of hind tarsi slightly longer than the rest combined. Length, 2.75-3 mm

Hab — Queensland Mount Tambourine (A M Lea), National Park (H Hacker), New South Wales Clarence River (A and R Zietz), National Park, Wollongong, Sydney (Lea)

A small, shining species, close to *M ordinaria*, but head black and legs pale, from *M femoralis* (= *M nigricornis*) it differs in having pale tibiae and much less conspicuous elytral punctures, *M pictifrons* has also stronger punctures and much of the head pale. The infuscation of the tibiae is usually slight and the front ones are sometimes entirely pale, on two specimens the scutellum is flavous, but on forty-two others it is black. Some of the larger punctures on the elytra are rather sharply defined, but they are mostly inconspicuous. The true epipleurae seem to terminate just beyond the hind coxae, but the elytral margins beyond them are narrowly flattened inwards almost to the apex, so that it is difficult to decide as to where the epipleurae really end, the species, however, is so obviously closely allied to several that have been referred to *Monolepta* without question that it seems undesirable to refer it to *Candezea*. The female differs from the male in having slightly smaller eyes, antennae and legs thinner and shorter, abdomen wider and the apical segment without a narrow deep longitudinal impression on each side of the median third

MONOLEPTA ALBICOLLIS, n sp

♂ — Black, shining, prothorax and legs almost white, tarsi and part of tibiae infuscated, three basal joints of antennae and parts of the mouth more or less reddish.

Head with unusually large and prominent eyes. Antennae rather long and thin, third joint slightly longer than second, their combined length slightly more than fourth. Prothorax about once and one half as wide as long, sides increasing in width to near apex, front angles rounded off, hind ones obtuse, median transverse impression rather shallow and interrupted in middle, punctures minute. Elytra subparallel-sided to near apex, with small and minute punctures, the former rather sharply defined, epipleurae very narrow at hind coxae. Apical segment of abdomen with two narrow deep longitudinal impressions. Basal joint of hind tarsi half as long again as the rest combined. Length, 2.75-3 mm.

♀ - Differs in having much smaller eyes, shorter antennae and legs, and apical segment of abdomen simple.

Hab—Queensland. Cairns district (F. P. Dodd).

In size and general appearance strikingly close to the preceding species, but may be at once distinguished by the eyes, on the male of this species the eyes, measured across the widest part of the head, are so large that the interocular space is distinctly less than the diameter of each of them; on the male of the preceding species the interocular space is double the diameter of an eye; the female of this species has larger eyes than the male of the former but the disproportion is less striking, the basal joint of the hind tarsi is longer, the prothorax is less transverse, and it and the legs are paler. On the type male the apical segment of abdomen is obscurely pale; on one female part of it is still more obscurely pale but on another it is as dark as the rest of the surface. On the male the interocular groove appears more like a shallow fovea than a narrow groove; on the female the groove is more evident, but it has a small fovea behind its middle as well as a subtriangular impression in front, from some directions the elytra appear to be minutely granulate posteriorly.

MONOLEPTA SOROR, n. sp.

Black, shining, head, prothorax, scutellum, front and middle legs (except the tarsi and parts of tibiae which are infuscated) flavous.

Head with interocular groove almost straight, a small triangular impression in front of its middle. Eyes not very large. Antennae long and thin, second and third joints equal, their combined length equal to fourth. Prothorax twice as wide as long, widest near apex, front angles rounded off, hind ones feebly dentate, median transverse impression well defined, even in middle, punctures dense and small but sharply defined. Elytra almost parallel-sided to near apex, with dense punctures of moderate size on basal half, becoming smaller but quite distinct posteriorly, epipleurae very narrow at hind coxae. Basal joint of hind tarsi slightly longer than the rest combined. Length, 3 mm.

Hab—New South Wales. Jenolan (J. C. Wibur).

Structurally and in general appearance close to *M. minuscula*, but head pale, antennae entirely black, hind legs dark, elytra with larger and more distinct punctures and normal epipleurae, from *M. ordinaria* it differs in being smaller and in the colour of its legs.

MONOLEPTA ARACETA, n. sp.

Black or blackish-brown, head, prothorax, scutellum, most of legs, and three basal joints of antennae more or less flavous.

Head with interocular groove straight, a narrow impression in front of its middle. Eyes not very large. Antennae long and thin, third joint distinctly longer than second, their combined length slightly longer than fourth. Prothorax

not twice as wide as long, sides slightly irregular near apex, a small tooth in each hind angle, median transverse impression absent, punctures dense and sharply defined throughout. Elytra slightly dilated posteriorly, punctures dense and sharply defined, about as large as on prothorax posteriorly, but larger towards base, epipleurae very narrow at hind coxae. Basal joint of hind tarsi slightly longer than the rest combined. Length, 2.5-3 mm.

Hab—New South Wales. Jenolan (J. C. Wiburd and A. M. Lea), Mittagong, Armidale (Lea), Baan Baa (G. E. Bryant), Dorrigo (W. Heron).

About the size of *M. femoralis*, but elytral punctures not quite as strong, those of the prothorax stronger, and head, except for some of the mouth parts, entirely pale. The femora (except the knees) tibiae and tarsi are often infuscated, occasionally the front legs are entirely pale, and on one specimen all the legs are pale, the apical joints of the antennae are usually black, but the infuscation decreases till the fourth is sometimes but little darker than the third. The elytra are seldom deep black, and sometimes are almost entirely obscurely tinted with red, or with the apical portion obscurely reddish, one specimen has the metasternum and abdomen obscurely reddish, another has the middle of those parts paler than their sides. From some directions the prothorax appears to be minutely granulate. The male differs from the female in having slightly larger eyes, antennae somewhat longer and apical segment of abdomen with a median fovea.

MONOLEPTA ERYTHRODERES, n. sp.

♂—Black, shining, prothorax red.

Head with a small fovea in the middle of the interocular groove. Eyes rather small. Antennae long and thin, second and third joints of equal length and combined, slightly longer than fourth. Prothorax not twice as wide as long, sides gently rounded, hind angles unarmed, median transverse impression rather shallow, entrenched in middle, punctures minute but fairly sharp. Elytra slightly dilated posteriorly, with dense and, for the genus, rather strong but somewhat rugose punctures. Two narrow longitudinal impressions on apical segment of abdomen. Basal joints of hind tarsi slightly longer than the rest combined. Length, 3 mm.

Hab—New South Wales. Captain's Flat (Aug. Simmon).

About the size of *M. femoralis*, and punctures of elytra much the same, but prothorax distinctly reddish instead of almost lemon-coloured, femora darker and basal joint of hind tarsi longer, from *M. modesta* it differs in being smaller, legs black and elytra not at all metallic, *M. minuscula* has paler legs and much smaller elytral punctures. Of the three specimens under examination one has the knees and coxae, and another has the under surface of the three basal joints of antennae obscurely reddish, but otherwise the legs and antennae are entirely black.

Other specimens from New South Wales (National Park and Sydney), Victoria (Mount Hotham) and Tasmania (Hobart) that appear to belong to the species have the prothorax decreasing in colour to flavous, two have the knees slightly paler than the adjacent parts, two have the knees and coxae conspicuously paler and one has these parts and the three basal joints of antennae pale.

MONOLEPTA CRIBRIPENNIS, n. sp.

♂—Black, head in front of interocular groove, prothorax, and most of legs flavous, three basal joints of antennae partly pale.

Head with interocular groove rather deep in middle, and with a small impression both in front and behind there, behind the groove finely transversely

strigose, and with numerous small punctures. Eyes prominent but not very large, their combined width being slightly less than the interocular space. Antennae long and fairly thin, second and third joints combined decidedly shorter than fourth. Prothorax fully twice as wide as long, sides gently rounded, median transverse impression conspicuous, scarcely enfeebled in middle, punctures dense and sharply defined, but smaller and sparser in depression. Elytra parallel-sided to near apex, with dense, sharply defined and (for the genus) decidedly large punctures, epiplemae very narrow at hind coxae. Fifth segment of abdomen large, a narrow deep longitudinal impression commencing on each side of the medio-apical third. Basal joint of hind tarsi about one-third longer than the rest combined. Length, 3.5-3.75 mm.

♀—Differs in having the head and eyes smaller, antennae somewhat thinner and shorter, and fifth segment of abdomen smaller, more pointed, and without longitudinal impressions.

Hab—New South Wales. Jenolan (J. C. Wihard), Victoria. Dividing Range (Rev. T. Blackburn).

Larger than *M. pictifrons*, labrum only vaguely infuscated in front, elytra intensely black and with larger punctures, at first glance it is somewhat suggestive of small Cleridae, such as *Lemidia flavicollis* and *L. erilis*. The upper surface of the three basal joints of antennae are dark, and the lower pale, but from the sides these joints appear to be striped, the two apical joints of the tarsi are infuscated and the extreme base of each of the first and second joints of the hind tarsi is black.

MONOLEPTA TRICHOPTERA, n. sp.

Black, prothorax (including prosternum) and part of under surface of head flavous. Elytra moderately densely clothed with short, upright pubescence.

Head with interocular groove distinctly curved, its sides passing to the back of the eyes, a subtriangular impression in front of its middle. Eyes rather small. Antennae moderately long and not very thin, second and third joints combined distinctly longer than fourth. Prothorax almost twice as wide as long, sides gently rounded, median transverse impression very conspicuous, slightly enfeebled in middle, punctures mostly minute and inconspicuous, but some sharply defined. Elytra with sides feebly dilated in middle, with crowded punctures of moderate size, mostly sharply defined but in parts rugose, with faint traces of striation. Basal joint of hind tarsi slightly longer than the rest combined. Length, 3.3-2.5 mm.

Hab—New South Wales. Illawarra (G. Compere), Sydney (Dr. E. W. Ferguson).

Readily distinguished from the many similarly coloured species, except the following, by the conspicuously pubescent elytra.

MONOLEPTA IRRANA, n. sp.

♂—Black, head (except parts of mouth) and prothorax flavous, knees, coxae, and three basal joints of antennae obscurely pale. Elytra rather densely clothed with short, upright pubescence.

Head with interocular groove slightly curved. Eyes not very large. Antennae moderately long and not very thin, second and third joints combined slightly longer than fourth. Prothorax not twice as wide as long, sides gently rounded, hind angles subdentate; transverse impression rather shallow towards sides, very feeble in middle; punctures irregularly distributed and mostly minute. Elytra almost parallel-sided to near apex, with crowded and rather small but

sharply defined punctures, epipleuræ scarcely traceable beyond hind coxæ. Basal joint of hind tarsi slightly longer than the rest combined. Length, 2.75 mm.

Hab—Queensland. Mount Tambourine (A. M. Lea).

Allied to the preceding species, but head pale, prothorax with transverse impression feeble and elytra with more even punctures. The apical segment of the abdomen of the type has two narrow longitudinal impressions, and the middle is shallowly depressed from apex to base but the depression may be a postmortem one.

(Group 3) *Prothorax* entirely pale, elytra with distinct markings.

MONOLEPTA FLAVOINCISA, n. sp. (Text-fig. 11.)

♂—Black and flavous.

Head wide interocular groove moderately curved and deep. Eyes large and prominent. Antennæ rather long and thin, second and third joints combined slightly longer than fourth. Prothorax about once and one half as wide as long, at widest slightly less than width of head across eyes, sides gently rounded, hind angles slightly dentate, median transverse impression represented by a shallow furrow towards each side, punctures inconspicuous. Elytra not very wide, almost parallel-sided to near apex, punctures small and rugose, epipleuræ very narrow at hind coxæ. Basal joint of hind tarsi slightly shorter than the rest combined. Length, 3 mm.

Hab—Northern Territory. Groote Eylandt (N. B. Tindale).

The prothorax is brightly flavous, the legs are flavous with parts of the tarsi (always including the claw-joint) moderately or slightly infuscated, the base, apex, suture, and sides of elytra are rather widely black or blackish, so that a pale (almost white) vitta, about half the width of each elytron, extends from about one-sixth from base to the same from apex, and is completely enclosed, the upper surface of the head is almost entirely black, but part of the lower surface is pale, the three basal joints of antennæ are pale, the others on two specimens are rather deeply infuscated, but on another most of them are black, the metasternum is rather deeply infuscated, and parts of the abdomen rather lightly so. The sides of the eyes of the male are visible when the prothorax is viewed from behind at an angle of 45° from the vertical, the elytral punctures are mostly very small, and few of them are at all sharply impressed. Two females that probably belong to the species differ in having the eyes smaller, prothorax wider and slightly wider than the head across eyes, elytra wider and with more distinct punctures, metasternum less infuscated and fifth segment of abdomen without longitudinal impressions. Five specimens were obtained.

This species is one of a group of closely allied tropical ones, of which I can distinguish at least five by their males, but the females are much less distinctive, they all have the pale parts of each elytron completely enclosed by black, and usually have the basal joint of hind tarsi slightly shorter than the rest combined. *Morphosphaera cineta* Blackb. (which is probably a *Monolepta*) has the general appearance of species of the group, especially *M. virgata*, from which it differs in having the head pale, eyes smaller, antennæ shorter and stouter, prothorax less transverse and elytral punctures more sharply defined, although not larger. *Luperus piceomarginatus* Jac., by the description, seems also very close to that species. A short special table of the males only of the species of the group may be useful.

- A Prothorax black or blackish *dispar*
 AA Prothorax entirely pale
 B Width across eyes greater than that of prothorax
 a Dark part of suture rather wide *flavoinclusa*
 aa Dark part very narrow *melanostetha*
 BB Width across eyes less than that of prothorax
 C Basal joint of hind tarsi shorter than the rest combined *virgata*
 CC Basal joint longer than the rest combined *polluta*

MONOLEPTA VIRGATA, n sp (Text-fig 12)

♂—Black and flavous

Head with interocular groove narrow and curved, a small impression in front of its middle, and one behind it. Eyes moderately large and prominent. Antennae moderately long and not very thin, second and third joints combined equal to fourth. Prothorax about once and one half as wide as long, greatest width slightly more than head across eyes, median transverse impression rather shallow towards sides, and just perceptibly traceable across middle, punctures minute but rather sharply defined. Elytra parallel-sided to near apex, with rather dense and small, rugose punctures, and minute but fairly sharp ones, epipleurae scarcely traceable beyond hind coxae. Basal joint of hind tarsi slightly shorter than the rest combined. Length, 3.75–4 mm.

♀—Differs from the male in having the head and eyes slightly smaller, antennae shorter, and apical segment of abdomen without two longitudinal impressions.

Hab—Northern Territory. Groote Eylandt (N. B. Tindale).

Larger than the preceding species, eyes of male smaller (so that when viewed from behind they disappear at an angle from which the sides of those of that species are quite distinct); the colours and markings are much the same, except that the head in front of the interocular groove (less an infuscation of the labrum) is flavous, and a greater portion of its under surface pale, the pale portions of the elytra are of the same shade, but extend nearer to the base and apex, so that at first they appear to extend quite to the base, instead of being completely enclosed, as they really are, the black sutural parts combined, except near apex, are slightly wider than the whitish parts of each. Two males and one female were obtained.

MONOLEPTA DISPAR, n sp (Text-figs 13, 14)

♂—Blackish, a wide whitish vitta on each elytron, legs and antennae partly flavous and partly infuscated.

Head with interocular groove moderately curved, a subtriangular impression in front of its middle. Antennae long and thin, second and third joints combined slightly but distinctly longer than fourth. Prothorax about once and one half as wide as long, greatest width slightly greater than that of head across eyes, median transverse depression distinct towards sides, interrupted in middle, punctures inconspicuous. Elytra rather thin, parallel-sided to near apex, punctures dense, rather small and mostly rugose, epipleurae not passing hind coxae. Basal joint of hind tarsi almost as long as the rest combined. Length, 2.5–2.75 mm.

Hab—Northern Territory. Port Darwin (W. K. Hunt).

Structurally close to *M. flavoinclusa*, but antennae thinner, eyes smaller and prothorax and abdomen blackish. The dark part of each elytron is wider at the suture than the side, and at the apex than the base, the sutural markings con-

joined are wider than the whitish vitta on each, on two specimens the prothorax and dark parts of the elytra are almost as black as the head, on a third the disc of the pronotum is obscurely dilated with red, on two of them three basal joints of antennae are pale, the following ones being deeply and evenly infuscated, on the other specimen only the tips of the joints after the third are infuscated, although the basal parts are rather dingy, on two of them the femora, tarsi and tips of tibiae are infuscated, the rest of the legs being of a rather dingy flavous or testaceous, on the third specimen only the knees are pale

MONOLEPTA MELANOSTETHA, n sp

Black and flavous, some parts infuscated

Head with interocular groove moderately curved, rather wide in middle, where in front of it there is a subtriangular impression. Eyes large and prominent. Antennae rather long and thin, second and third joints combined almost the length of fourth. Prothorax about once and one half as wide as long, greatest width slightly less than that of head across eyes, median transverse impression distinct towards sides, but interrupted in middle, punctures inconspicuous. Elytra not very wide, sides almost parallel to near apex, punctures dense and small, usually sharply defined but somewhat rugose, epipleurae not traceable beyond hind coxae. Basal joint of hind tarsi slightly shorter than the rest combined. Length, 3 mm

♀—Differs in being slightly more robust, eyes smaller, antennae shorter, abdomen flavous with apical segment black, and without two longitudinal impressions

Hab—Northern Territory. Darwin (G. F. Hill and W. K. Hunt)

The flavous parts are the prothorax and legs, but the tarsi and parts of tibiae are more or less infuscated, the three basal joints of antennae are partly or entirely pale, the others are infuscated, the elytra are almost white, but each is completely margined with black or blackish, the dark sutural part is narrow, the dark marginal parts are rather wide, but appear very narrow from directly above. The male has most of the abdomen infuscated, on the female it is flavous, except for the apical segment

MONOLEPTA POLLUTA, n sp

♂—Black and flavous, some parts infuscated

Head with interocular groove moderately curved, a narrow impression in front of its middle. Eyes prominent and moderately large. Antennae long and rather thin, second and third joints combined slightly shorter than fourth. Prothorax about once and two-thirds as wide as long, greatest width slightly in excess of that of head across eyes, sides moderately rounded, hind angles feebly dentate, median transverse impression rather wide and shallow towards sides, enfeebled in middle, punctures dense and minute. Elytra not very narrow, sides feebly dilated to about middle; with dense and small punctures, mostly shallow and rugose, epipleurae narrow at hind coxae, but traceable beyond them. Basal joint of hind tarsi slightly longer than the rest combined. Length, 3.75 mm

Hab—Northern Territory. Roper River (N. B. Tindale)

With the general appearance of *M. flavomolosa*, but prothorax more transverse, and it and the elytra less shining, with the epipleurae of the latter longer, the elytra are rather dull compared with others of the group, but could scarcely be called opaque. The flavous parts are the prothorax, elytra (except all their margins) and parts of the legs, the femora are infuscated in middle, but the

infuscation of the front pair is very slight; the three basal joints of antennae are paler than the others, which are infuscated, either entirely or at their tips, the pale parts of the elytra are completely enclosed, but more narrowly than on the other closely allied species, they are also scarcely paler than the prothorax, instead of almost white. On the type the head is rather dark but not blackish, on a second specimen it is paler but still dingy.

MONOLEPTA BIVITTIALBA, n.sp. (Text-figs 15-17)

♂—Black, each elytron with an almost white vitta, muzzle, antennae and legs partly pale.

Head with interocular groove moderately curved, a narrow deep impression in front of its middle, and a smaller one behind it. Eyes not very large. Antennae rather long and thin, third joint decidedly longer than second, and slightly shorter than fourth. Prothorax almost twice as wide as long, sides moderately rounded, hind angles dentate, without transverse median impression, punctures inconspicuous. Elytra not very wide, sides nearly parallel to beyond the middle, punctures dense and small but usually sharply defined; epipleurae very narrow at hind coxae. Apical segment of abdomen foveate in middle. Basal joint of hind tarsi slightly shorter than the rest combined. Length, 2.75-3 mm.

♀—Differs in having the head and prothorax flavous, elytra with the suture narrowly dark throughout (more narrowly in some parts than others) and the margins narrowly infuscated, legs almost entirely pale, antennae thinner, elytra slightly more dilated posteriorly, and abdomen nonfoveate.

Hab—South Australia. Port Lincoln, Murray Bridge (A. M. Lea). Victoria. Gisborne (J. C. Goudie, No. 830).

The male at first glance resembles *M. dispar*, but the third joint of antennae is distinctly longer in proportion, a whitish vitta is enclosed on each elytron, but the dark lateral part on each is not even throughout, as a portion diverges with a free posterior end, from above, the whitish vitta appears to be free on each side near the apex, the female has colours somewhat as on a cotype of *M. tricolor*, but the size, shape and punctures are all different, on one of them there is an elongated infuscation towards the side of each elytron, on another this is not evident. On the male most of the muzzle is pale, its antennae have the three basal joints pale, the next one or two partly pale, the others entirely dark, its femora are almost black in the middle, and the tarsi and tips of tibiae infuscated.

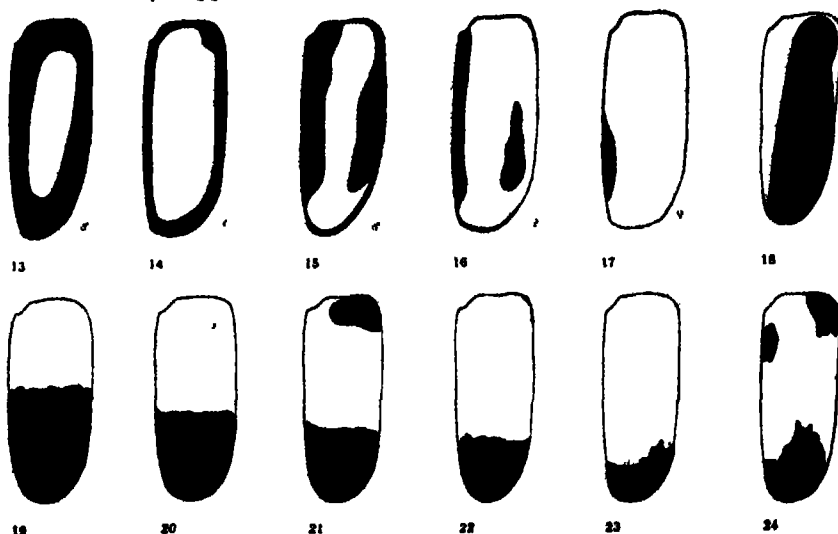
MONOLEPTA FLAVOSUTURALIS, n.sp. (Text-fig 18)

Testaceo-flavous, elytra blackish except along suture (rather widely towards base) at base and on basal half of sides, antennae with the basal joints pale, the five following ones blackish (the others missing), tarsi slightly infuscated.

Head with interocular groove curved but feeble, behind it finely transversely strigose and with rather dense punctures, a conspicuous median line to base. Eyes moderately large. Antennae moderately long, third joint longer than second, the two combined slightly longer than fourth. Prothorax about once and one half as wide as long, sides gently rounded and with rather wider margins than usual, a faint median line on basal half, but median transverse impression absent, with dense and small, sharply defined punctures. Elytra feebly diminishing in width from near base, punctures slightly larger than on prothorax; epipleurae traceable almost to apex of second segment of abdomen. Basal joint of hind tarsi about as long as the rest combined. Length, 6.5 mm.

Hab—North-Western Australia (Blackburn's collection).

Allied to *M. tepperi*, but larger, head different at and behind the interocular groove, and dark part of each elytron touching the apex and the side beyond the middle. The type appears to be a female.



Text-figs 13-24 Elytral Patterns of species of *Monolepta*

13-14 *M. dispar* Lea. 15-17 *M. bivittata* Lea. 18 *M. flavosuturalis* Lea.
19-20 *M. semiflava* Lea. 21-22 *M. caviventris* Lea. 23 *M. trimorpha* Lea, form 1.
24 *M. trimorpha* Lea, form 2.

MONOLEPTA HETERODOXA, n sp.

♂—Flavous, elytra black with a faint pruinose gloss, suture and other margins narrowly pale; metasternum and abdomen blackish, three basal joints of antennae pale, the others infuscated, but some with the base pale, two apical joints of tarsi infuscated, extreme base of the hind ones black.

Head with interocular groove almost straight, a small triangular impression in front of its middle. Eyes prominent and moderately large. Antennae rather long, third joint subtriangular, slightly longer than second, the two combined slightly longer than fourth to sixth, rather wide and serrated on one side, the following ones less serrated, with the eleventh simple. Prothorax twice as wide as long, sides gently rounded, median transverse impression wide and shallow, somewhat enfeebled in middle, punctures dense and small. Elytra parallel-sided to near apex, with dense and rather small but sharply defined punctures, a narrow curved carina or U-shaped elevation on each side near suture, just below summit of apical slope, epipleurae traceable to about apex of first segment of abdomen. Basal joint of hind tarsi about one-third longer than the rest combined, basal joint of each of the others rather strongly inflated. Length, 4 mm.

Hab—Queensland Dalby (Mrs F. H. Hobler).

The two principal shades of colour are much as on *M. tepperi*, but the two species are not closely allied. The serrations of the antennae and dilated basal joints of front and middle tarsi are unusual in *Monolepta*. The apical segment of the abdomen has a narrow longitudinal impression on each side of the medio-

apical third, and a shallow median impression, the metasternum has a large heart-shaped fovea, but this, as also the median one on the abdomen, may be due to postmortem contractions, the curious subapical elevations of the elytra are symmetrical, and so are apparently normal

MONOLEPTA SEMIFLAVA, n. sp. (Text-figs 19, 20)

Bright flavous, apical two-fifths of elytra, abdomen and eight apical joints of antennae black, tarsi and some of the mouth parts infuscated

Head with interocular groove narrow, curved to behind eyes, a very small impression in front of middle. Eyes rather small. Antennae thin but not very long, second and third joints combined the length of fourth. Prothorax about once and one half as wide as long, sides increasing in width to near apex, median transverse impression rather deep and wide, interrupted in middle, punctures dense and minute. Elytra not very long, sides feebly dilated to near apex, punctures dense and rather small but sharply defined, epipleurae very narrow at hind coxae. Basal joint of hind tarsi about one-fourth longer than the rest combined. Length, 3.25-3.5 mm

Hab.—Queensland: Brisbane Island (H. Hacker and A. M. Lea), Stradbroke Island (J. H. Borcham), New South Wales: Jenolan (J. C. Wiburd)

Somewhat suggestive of *M. dilosa*, but less of elytra black and the pale colour flavous, instead of reddish, the antennae also are somewhat thinner. The female differs from the male in being slightly more dilated posteriorly, antennae shorter, and apical segment of abdomen smaller and without two narrow longitudinal impressions. The specimen from Jenolan has about one-fourth more of the elytra black than the others

MONOLEPTA CAVIVENTRIS, n. sp. (Text-figs 21, 22.)

♂—Flavous, shoulders and apical third of elytra blackish, three or four basal joints of antennae pale but dingy, the others and parts of the tarsi infuscated

Head with interocular groove deep and slightly curved, a small triangular impression in front of its middle. Eyes rather large. Antennae long and rather thin, second and third joints combined slightly longer than fourth. Prothorax scarcely once and one half as wide as long, sides dilated to near apex, front angles rounded, hind ones subdentate, median transverse impression rather wide and shallow, interrupted or at least enfeebled in middle, punctures minute. Elytra rather elongate, parallel-sided to near apex, punctures minute and mostly rugose, epipleurae very narrow at hind coxae. Apical segment of abdomen large, with a wide, deep, elliptic excavation from base to apex. Basal joint of hind tarsi slightly longer than the rest combined. Length, 3.25-3.75 mm

♀—Differs in having the head and eyes smaller, antennae shorter, and apical segment of abdomen much smaller and simple

Hab.—Northern Territory: Groote Eylandt (N. B. Tindale)

The whole apical third of elytra is blackish, but the humeral spots are somewhat as on *M. biguttigera*; on two specimens each spot extends more than half way from the side to the scutellum, but they are usually smaller, on one specimen only a faint deepening of colour indicates their position. On the female the tip of both surfaces of the abdomen is dark, on the male the tip of only the dorsal surface, normally concealed, is dark. The great abdominal cavity of the male is evidently natural, and not due to postmortem contractions as it is exactly alike on five males. Thirteen specimens were obtained

MONOLEPTA TRIMORPHA, n.sp (Text-figs. 23, 24)

♂.—Flavous, antennae, palpi, apical fifth of elytra, abdomen (except part of basal segment) and extreme base of hind tarsi black, parts of tarsi infuscated.

Head with interocular groove shallow and interrupted in middle. Eyes large and prominent. Antennae long and thin, passing tips of elytra, second and third joints very short, combined less than half the length of fourth. Prothorax almost twice as wide as long, sides almost straight to near apex, median transverse impression slight towards sides, widely interrupted in middle, punctures small but sharply defined. Elytra almost parallel-sided to near apex, with dense and small punctures, mostly rugose, epipleurae very narrow at hind coxae. Basal segment of abdomen with a narrow longitudinal impression on each side of the median third. Basal joint of hind tarsi about one-third longer than the rest combined. Length, 5-6 mm.

♀—Differs in having the head and eyes smaller, antennae shorter, with the second and third combined slightly more than half the length of fourth, abdomen with first and second segments pale, and the fifth ample.

Hab.—Northern Territory. Woodah Island (N. B. Tindale).

There are three forms under examination, and the one regarded as typical is represented by three males and one female, on this form the black part of the elytra covers the tips but is irregular on its front edge. Each eye at the greatest width of the head is about the width of the interocular space on the male, somewhat less on the female, there is a faint indication as of a small twelfth joint on the antennae of the males. From some directions the elytral punctures on the pale parts, owing to "waterlogging," appear to be larger than they really are. There are a few minute, erect setae on the apical slope of elytra, but they could be easily overlooked. Four specimens were obtained.

Form 2 ♀—Differs from the female of the typical form in having the black part of apex of elytra slightly enlarged, a black spot on each shoulder, and one on the suture near the base.

In general this form is fairly close to the description of *M. quinque maculata*, from the Kimberley district, but is larger, and the apical spots or markings are truly apical and conjoined at the suture, instead of subapical and free, the description of that species reads somewhat as if founded on *M. biguttigera*, except that that species is without a sutural spot. One specimen was taken on Woodah Island. A female from North-Western Australia (Blackburn's collection) probably belongs to this form, but has the interocular groove more pronounced, the three basal joints of antennae paler, and the prothorax with decidedly larger punctures.

Form 3 ♂—As Form 1, except that the elytra are entirely black. Two specimens were taken on Woodah Island.

From the numerous species of *Monolepta* with black elytra this form differs in its larger size and very short second and third joints of antennae.

MONOLEPTA COSTIPENNIS, n.sp (Text-figs 25, 26)

Of a dingy flavous, apical half of antennae and tips of some of the preceding joints infuscated, elytra and under surface variable.

Head with interocular groove slightly arched backwards. Eyes rather large. Antennae long and thin, third joint decidedly longer than second, their combined length slightly greater than fourth. Prothorax almost twice as wide as long, sides gently curved, arcuate towards base; without median transverse impression; punctures dense, somewhat irregular and small, but sharply defined. Elytra almost

parallel-sided to near apex, each with three acute costae; punctures slightly larger but not denser than on prothorax. epipleurae very narrow at hind coxae. Basal joint of hind coxae about once and one half the length of the rest combined. Length, 3.5-4 mm

Hab — Queensland (Aurus district (A. M. Lea).

Despite the great variability of this species it should be easily recognised by the elytral costae, of these the outer one on each elytron extends from near the basal third to the apical third, is parallel with the margin, and distant from it about the length of the third joint of antennae, from directly above it appears marginal, the second costa is somewhat shorter, and the same distance from the first that this is from the margin, the third is still shorter, close to the second, and rather less acute than the others. The four specimens under examination appear to be females and the abdomen is greatly shrivelled on all of them, as it is impossible to decide as to which of the four is typical, they have been numbered in accordance with the amount of black on the elytra.

1 Elytra blackish, but with a faint lessening of colour about the shoulders, abdomen black, most of metasternum blackish

2 Elytra black, with a wide, triangular, flavous median patch, the triangle with its base almost straight, and almost touching the sides near the shoulders, its tip on the suture about one-fourth from apex, abdomen pale, most of metasternum infuscated

3 As the preceding specimen, except that the base of elytra is not black, although the black is continued on the sides so as to cover the epipleurae, these being invisible from above

4 Elytra pale except for a faint infuscation posteriorly, under surface entirely pale

MONOLEPTA FASCICULATA, n.sp. (Text-fig 27)

♂—Red, front of head scutellum, basal fourth of elytra, a postmedian fascia of about the same extent, sides of mesosternum, apical segment of abdomen, a spot on each side of each of the others, legs (except coxae) and antennae black. Abdomen with four long fascicles of golden hair, two each at the apices of the third and fourth segments

Head with interocular groove almost straight, a small depression in front of its middle. Eyes moderately large. Antennae moderately long and thin, third joint slightly longer than second, their combined length more than fourth. Prothorax almost twice as wide as long, sides moderately rounded, median transverse impression scarcely traceable, even towards sides, punctures minute. Elytra rather long, almost parallel-sided to near apex, punctures rather dense and small but uneven, epipleurae scarcely traceable beyond hind coxae. Basal joint of hind tarsi about one-third longer than the rest combined. Length, 5 mm

♀.—Differs in having the head and eyes smaller, antennae shorter and thinner, elytra shorter and less parallel-sided and abdomen without fascicles.

Hab — Western Australia. Cue (H. W. Brown)

A pretty little insect, alternately bright red and black, and very distinct otherwise by the abdomen of the male

MONOLEPTA SUBSTRIATA, n.sp. (Text-fig 28)

Castaneo-flavous, elytra and antennae partly black

Head with interocular carina arched backwards in middle, the space in front of it irregularly elevated. Eyes large and prominent, the interocular space

scarcely one-third of the head at its widest. Antennae long and thin, second and third joints combined distinctly shorter than fourth. Prothorax about once and one half as wide as long, sides moderately rounded, hind angles rather strongly dentate, with rather dense and small, sharply defined punctures. Elytra with sides feebly dilated to near apex, with not very small punctures irregularly distributed and in places sublineate in arrangement, with distinct remnants of striation, epipleurae very narrow at hind coxae. Basal joint of hind tarsi about half as long again as the rest combined. Length, 4.75 mm.

Hab—Queensland (Cairns) (E. Allen)

In general appearance like some varieties of *M. peticollis* but with distinct traces of elytral striation, eyes larger, interocular space narrower and noticeably elevated, and groove arched backwards. The antennae of the type are damaged, only eight joints being present, of these the first is almost black except at the base, the second and third are infuscated towards the apex, and the following ones have the apical half of each black or infuscated. The elytra are not as polished as the prothorax, as their derm is slightly shagreened, then greater portion is black, the pale portion is of an irregularly oblong shape, and occupies the median third in width and rather more than the median half in length, its margins neither sharply defined nor even, the under surface, palpi, and legs, except the claws, are entirely pale. The prothorax has a small and irregular fovea on each side of the middle, apparently representing the median transverse impression. The type is probably a female as the fifth segment of its abdomen is small and without narrow, longitudinal impressions.

MONOLPTA OCTONOTATA, n. sp. (Text-fig. 29)

♂—Flavous, antennae, except three basal joints, eight spots on elytra, and extreme base of hind tarsi black, two apical joints of each tarsus infuscated.

Head with interocular groove arched forwards, a small depression in front of its middle. Eyes large. Antennae long and not very thin, second and third joints combined scarcely half the length of fourth. Prothorax about once and two-thirds as wide as long, front angles rounded off, hind ones subdentate, median transverse impression rather wide and deep, scarcely enfeebled in middle, punctures small but rather sharply defined. Elytra rather thin almost parallel-sided to near apex, punctures dense, rather small and somewhat rugose, epipleurae very narrow at hind coxae. Apical segment of abdomen with a narrow impression on each side of the medio-apical third. Basal joint of hind tarsi about half as long again as the rest combined. Length, 4.25-4.5 mm.

♀—Differs in having the head and eyes smaller, antennae shorter and thinner, second and third joints combined slightly more than half the length of fourth, elytra less parallel-sided and apical segment of abdomen simple.

Hab—North-Western Australia (Macleay Museum)

With eight elytral spots as on *M. megalops*, but the four near the base differently placed and the prothorax immaculate. The spots on the elytra are small and oval, the subbasal ones are not in a straight line, the median ones, which are close to the suture, being slightly posterior to the others, which are on the shoulders, the four posterior ones are also not in a straight line, the median ones being slightly anterior to the others, as a result the outer spots on each elytron are about half as far apart again as the inner ones, on the female the spots near the suture are scarcely indicated.

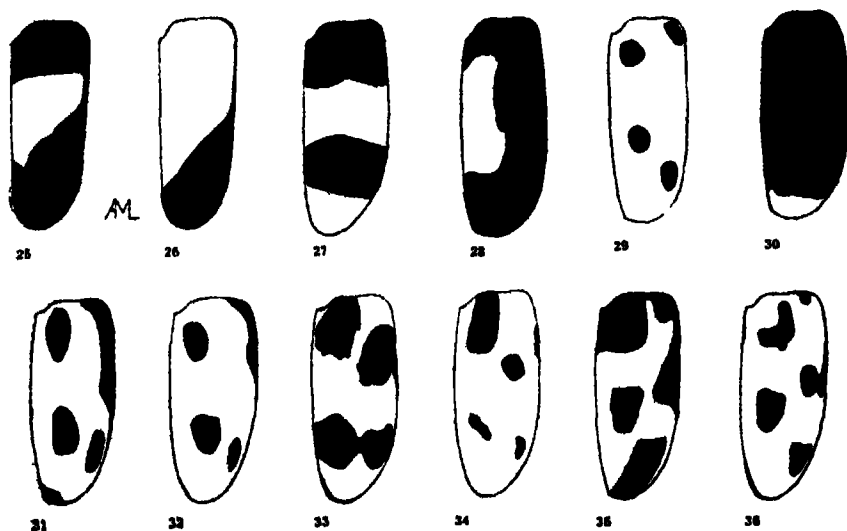
MONOLEPTA LATICOLLIS, n. sp.

Pale dingy flavous, some parts more or less deeply infuscated, extreme base of hind tarsi black.

Head less convex than usual, interocular groove straight, a small triangular impression in front of its middle. Eyes large. Antennae rather long and thin, second and third joints combined slightly longer than fourth. Prothorax distinctly more than twice as wide as long, sides gently rounded, median transverse impression rather shallow towards sides, faintly traceable in middle, with dense and small, rugose punctures. Elytra rather thin almost parallel-sided to near apex, punctures somewhat larger than on prothorax and also rugose. Basal joint of hind tarsi almost twice the length of the rest combined. Length, 2.5 mm.

Hab—North-Western Australia (Macleay Museum).

A minute species with unusually wide prothorax. The two specimens, apparently females, under examination, vary somewhat in the extent and intensity



Text-figs 25-36 Elytral Patterns of species of *Monolepta*

25 *M. costipennis* Lea, form 2 26 *M. costipennis* Lea, form 3 27 *M. fasciculata* Lea 28 *M. substriata* Lea 29 *M. octonotata* Lea 30 *M. terminalis* Weiss 31-32 *M. trivitticollis* Lea 33-34 *M. megalops* Lea 35-36 *M. bivitticollis* Lea

of the markings, on one of them the head, seven apical joints of antennae, and the under surface, are faintly infuscated, the sides of the prothorax and some obscure spots about the middle are slightly darker, on the elytra the suture and margins, including both margins of epipleurae, are narrowly infuscated, there are two conjoined spots on each elytra close to the suture near the base, three small spots towards the sides about the middle, and a wide postmedian fascia, directed obliquely backwards and not touching the margins. On the second specimen the infuscations of the prothorax are very feeble, the two spots on each elytron near the scutellum are free, although close together, there is but one lateromedian spot, and that very faint, and the postmedian fascia is less regular.

*Group 1 Prothorax of two colours**MONOLEPTA TRIVITTICOLLIS*, n.sp. (Text-figs 31, 32)

♂—Flavous, prothorax with three longitudinal vittae, elytra with numerous markings, most of antennae and extreme base of hind tarsi black.

Head with interocular groove deep and almost straight, a triangular impression in front of its middle. Eyes large and prominent. Antennae rather long and thin, second and third joints combined the length of fourth. Prothorax fully twice as wide as long, sides gently rounded, median transverse impression very shallow, scarcely traceable across middle, punctures small, but in places sharply defined. Elytra rather long and subelliptic, punctures of moderate size and sharply defined, becoming smaller posteriorly, epipleurae very narrow at hind coxae. Apical segment of abdomen rather densely clothed, with two narrow longitudinal impressions. Basal joint of hind tarsi almost twice as long as the rest combined. Length, 3.5-4.25 mm.

♀—Differs in having slightly smaller head and eyes, antennae slightly shorter and thinner, the second and third joints combined slightly longer than fourth, elytra slightly wider in middle, apical segment of abdomen less densely clothed and without longitudinal impressions.

Hab—New South Wales. Hastings River (T. G. Sloane), Hornsby (C. Hibbons).

The elytra, with more than two spots on each, distinguish this species from *M. biguttigera* and *M. sparsipennis*, with which it would be associated in Blackburn's table. The three prothoracic vittae extend from base to apex; the median one is narrowest at the apex, the marginal ones are widest there, on each elytron there is a black vitta extending from the base along the side, including the epipleura, to just beyond the hind coxae, and three elliptic spots, the first sub-basal, nearer suture than shoulder and about the length of prothorax, the others postmedian, the inner one slightly in advance of the outer, larger and usually of irregular shape; the suture is very narrowly infuscated, but at the apex the infuscation is dilated into a spot, three basal joints of antennae are usually entirely pale, sometimes the following one is partly pale, and usually the base of the eleventh, there is often an infuscated median line on the head. On one female most of the abdomen is infuscated. In the male each eye at the widest part of the head is equal in width to the narrowest part of the interocular space, in the female it is somewhat less. A specimen from Cairns, from the Blackburn collection, is paler, the dark spots and markings are brownish, and the punctures are slightly larger.

MONOLEPTA MEGALOPS, n.sp. (Text-figs. 33, 34)

♂—Pale flavous, three spots on prothorax and five on each elytron brownish or blackish, extreme base of hind tarsi black, first and eleventh joints of antennae pale, the others more or less deeply infuscated.

Head with interocular groove slightly curved and deep, with distinct punctures behind it. Eyes unusually large. Antennae rather long and thin, second and third joints combined almost the length of fourth. Prothorax almost twice as wide as long, sides gently dilated to near apex and then rounded off; median transverse impression shallow towards sides, not traceable across middle, punctures small but sharply defined. Elytra moderately long and parallel-sided to near apex, punctures somewhat larger than on prothorax, but less dense, and not more sharply defined, epipleurae very narrow at hind coxae. Apical segment of

abdomen with two longitudinal impressions. Basal joint of hind tarsi about once and one half the length of the rest combined. Length, 4.4½ mm.

♀—Differs in having the head and eyes smaller, antennae shorter and thinner, elytra less parallel-sided, and apical segment of abdomen smaller and thinner.

Hab.—North-Western Australia. Fortescue River and Roebourne (W. D. Dodd).

In Blackburn's table this species would be associated with *M. biguttigera*, and *M. sparsipennis*, from which it is distinguished by each elytron having four dark spots; *M. figurata* is noted as having three infuscated spots on the pronotum, but also as having three spots on each elytron. The spots on the prothorax are not vittae complete from base to apex, as on the preceding species, but the median one terminates triangularly some distance from the base, and the outer ones touch neither base nor apex, on each elytron the spots are: a somewhat curved one, almost the length of the prothorax and touching base but not suture, a smaller one obliquely to the outer rear of the first, one touching the margin at about the basal fourth and partly continued on to the epipleura, and two postmedian ones almost in line with the first and second; the suture is rather deeply infuscated about the apex. Across the widest part of the head each eye of the female is almost the width of the interocular space, on the male this space is distinctly less than one-third of the total width.

VAR. Two specimens, sexes, from Queensland (Cunnamulla, H. Hardcastle) differ in being larger, 5 mm, the spots on the prothorax larger and the lateral ones on the female almost touching the base, the spots on the elytra are much larger, the first one on each almost touches the suture, the second is dilated so as to touch the marginal spot, and the postmedian ones on the female are conjoined to form an irregular fascia, crossing the suture but not touching the sides, as a result there are but four isolated markings on each elytron of the male and but two isolated ones and part of a fascia on each elytron of the female.

MONOLEPTA BIVITTICOLLIS, n. sp. (Text-figs 35, 36)

♂—Flavous, a median line on head, sides of prothorax, some large spots or markings on elytra, and extreme base of hind tarsi black, apical and three basal joints of antennae pale, the others infuscated.

Head with interocular groove moderately curved, a small impression in front of its middle and some small punctures between it and base. Eyes large, each almost as wide as the interocular space. Antennae rather long and thin, third joint slightly longer than second, their combined length slightly greater than fourth. Prothorax near apex, where it is widest, about twice as wide as long, median transverse impression rather feeble, widely interrupted in middle, punctures dense and sharply defined although small. Elytra rather thin and sub-elliptic, punctures of moderate size and small but mostly sharply defined, epipleurae very narrow at hind coxae. Apical segment of abdomen with two narrow, deep, longitudinal impressions. Basal joint of hind tarsi fully one half longer than the rest combined. Length, 4.4.25 mm.

Hab.—Northern Queensland (Blackburn's collection), Aloomba.

Close to the preceding species, but without a median spot on the prothorax, and the lateral markings continued to base; from *M. trivitticollis* it is distinguished by the bivittate prothorax and the scutellar blotch; in Blackburn's table, if referred to B.B.B., it would be associated with *M. biguttigera* and *M. sparsipennis*. The black of the sides of the prothorax is triangularly dilated from base to apex, but the front angles are pale, on the elytra the black parts are a transversely

oblong patch almost the size of the pronotum, about the scutellum, each shoulder and the side near it (including the epipleura) with the black dilated to about the middle, a suboblong median spot near the suture, and an oblique vitta behind it touching the suture at its apex.

A male from North-western Australia (Derby, Dr. A. M. Morgan) differs in being slightly smaller, and each elytron with markings appearing, from above, as five free spots, this is due to the oblong about the scutellum being reduced to a curved free spot on each elytron, a shoulder spot free from the lateral one near the base (although this is continued on to part of the epipleura), the submedian spot smaller, and the subapical one reduced to a rounded spot distant from the apex, two of the apical joints of its antennae are also pale instead of only one.

MONOLEPTA ARIDA, n. sp. (Text-figs. 37-39)

♂—Flavous, or pale castaneo-flavous, a large infuscation in each front angle of prothorax, elytra with five infuscated or blackish markings and the suture narrowly dark at apex, inner margins of epipleurae almost black, one or two apical joints of antennae and three basal ones pale, the others infuscated, extreme base of hind tarsi black.

Head with interocular groove moderately curved, a small impression in front of its middle. Eyes moderately large. Antennae rather long and thin, second and third joints combined slightly longer than fourth. Prothorax not quite twice as wide as long, median transverse impression feeble even on sides and not traceable across middle, punctures minute and mostly inconspicuous. Elytra rather thin and subelliptic, punctures small or moderately small but mostly sharply defined, epipleurae very narrow at hind coxae. Apical segment of abdomen with two narrow deep impressions. Basal joint of hind tarsi almost one half longer than the rest combined. Length, 3.75-4.5 mm.

♀—Differs in the usual details of head, antennae and abdomen.

Hab—South Australia: Oodnadatta and Heigott Springs (Rev. T. Blackburn), New South Wales: Mulwala (T. G. Sloane), Moree (W. W. Froggatt, No. 26/1917), Whetton (A. M. Lea), Victoria: Nyah (J. C. Goudie, No. 754).

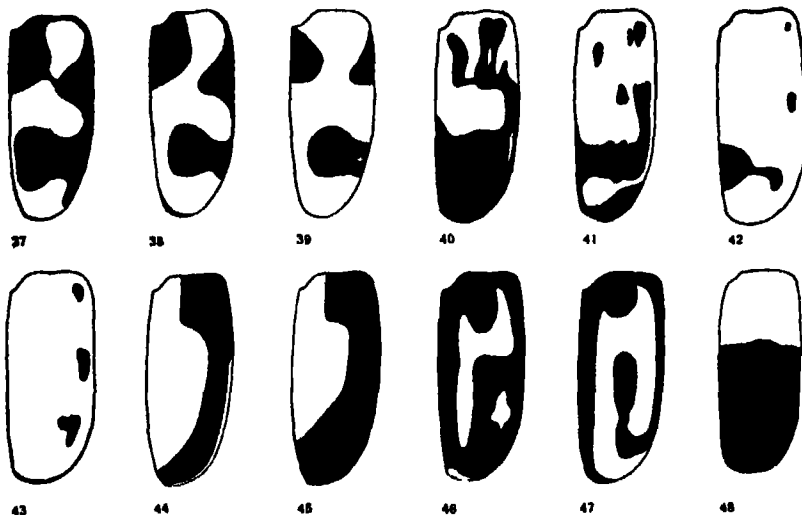
In Blackburn's table this species would be associated with *M. biguttigera* and *M. parvipennis*, but the markings on prothorax and elytra are different. On South Australian specimens the infuscations of the pronotum are sometimes so faint that they could fairly be referred to Group 3, on them the elytral markings from above appear to consist of five free spots: a subtriangular one common to both, commencing at the scutellum and dilated or bilobed to about one-fifth from the base (on one female this spot is cordate and touches the base each side of the scutellum), a subtriangular spot on each side about the basal fourth, and a large postmedian spot, this sometimes connected along the side with the postbasal spot, and occasionally broken into two, on two females parts of the metasternum and of the abdomen are infuscated, on three others and on four males the sternum and abdomen are entirely pale. On specimens from New South Wales and Victoria the markings are usually more extended, and the tip of the antennae is usually no paler than the tenth joint, on them the postmedian and postbasal markings of the elytra are rather widely connected along the sides and with the base, the scutellar patch is almost square and on one specimen is narrowly connected near its apex with the postbasal spots; on all of them the metasternum is blackish and parts of the abdomen infuscated; on a Victorian specimen the infuscations of the pronotum are conjoined.

MONOLEPTA INTRICATA, n sp (Text-figs 40, 41)

Of a rather dingy flavous or testaceous, upper surface with variable markings, sterna and abdomen usually infuscated towards sides, antennae infuscated, except parts of three basal joints, parts of tibiae and of tarsi usually slightly infuscated

Head with interocular groove slightly curved and rather deep, a triangular impression in front of its middle. Eyes moderately large. Antennae long and thin, second and third joints combined almost the length of fourth. Prothorax not twice as wide as long, sides moderately round, median transverse impression shallow and inconspicuous, punctures dense in most parts, and small, but sharply defined. Elytra with sides feebly dilated to beyond the middle, punctures slightly larger than on prothorax, epipleurae very narrow at hind coxae. Basal joint of hind tarsi scarcely, if at all, longer than the rest combined. Length, 3.5-4.25 mm

Hab—New South Wales Blue Mountains (Dr E W Ferguson), Jenolan



Text-figs 37-48 Elytral Patterns of species of *Monolepta* and *Candeeza*

37-39 *M. arida* Lea 40-41 *M. intricata* Lea 42-43 *M. laterivaria* Lea 44-45
M. medioflava Lea 46-47 *M. aberrans* Lea 48 *Candeeza seminigra* Lea

(J C Wiburd), Galston (S Dumbrell and A M Lea), Mittagong and Forest Reefs (Lea)

Allied to *M. implicata*, but more depressed, head and prothorax wider and elytral markings on a different plan. The markings of the upper surface are more or less piceous-brown, but sometimes in parts are hardly more than slight infuscations, there is a rather wide median line on the head, traceable sometimes to the front of the clypeus, on the prothorax there are three median spots, usually loosely conjoined to form a median Y, the margins are dark but to a variable extent, the scutellum is dark, on the elytra rather more than the apical third is dark, on one specimen entirely, but on six others enclosing a short pale fascia or two free spots, from each side of it a streak extends near the side to about the basal two-fifths, when it turns inwards to touch or nearly touch a small spot, the latter is sometimes narrowly connected with a humeral spot, and sometimes from its inner edge with a second place on the apical blotch, the humeral

spot is sometimes free, sometimes broken up into two, there is usually a free spot near the suture close to the base, on each elytron of one specimen there are three subbasal spots (including two on the shoulder) narrowly connected with obscure antemedian spots, and these connected along the side with the apical blotch, so that not one of the dark markings is free, the extreme base of the hind tarsi is not black. On some specimens the punctures, although scarcely longer, are more sharply defined than on others, this is especially the case with those on the pronotum. All the specimens described appear to be females.

MONOLEPTA LATHEIVARIA, n sp (Text-figs 42, 43)

Pale watery flavous, upper surface with some infuscated markings, three basal joints of antennae partly pale, the others infuscated, margins of elytral epipleurae narrowly dark.

Head with interocular groove straight, a narrow impression in front of its middle. Eyes rather large. Antennae long and thin, second and third joints combined slightly longer than fourth. Prothorax scarcely one-fourth wider than long, sides gently rounded, a feeble notch near apex, base subdentate, median transverse impression feeble, punctures rather dense and sharply defined, but in parts indistinct. Elytra slightly dilated to near apex, punctures of moderate size and sharply defined, with faint traces of striation, epipleurae very narrow at hind coxae. Basal joint of hind tarsi about one-fourth longer than the rest combined. Length, 4.25-5.25 mm.

Hab—Northern Queensland (Blackburn's collection)

On the head there is a slightly infuscated median line, the sides of the prothorax are narrowly but deeply infuscated and in its middle a very faint Y may be traced, on each elytron there are three small spots towards the sides, one on the shoulder, smallest and faint, one just before the middle and one fairly close to apex, in addition on the type there is a fairly large round blotch, about the size of the head, about the summit of the apical slope, on a second specimen the elytral markings are still more faint, and the sutural blotch is hardly more than indicated. A specimen from the Cairns district (A. M. Lea), has the three outer spots on each elytron somewhat larger and more distinct and the sutural blotch absent, but the suture itself has a narrow infuscation which is continued around the tips to join in with a narrow marginal infuscation, the transverse impression of its pronotum is also more distinct. The three specimens at first glance apparently, on account of the sides of the prothorax, belong to one of the many varieties of *M. implicata*, but the head is larger, the prothorax longer, with smaller punctures and a wide vague depression, so that, when viewed from the sides it appears at its lowest in the middle, on *M. implicata*, when so viewed, it appears more convex there than elsewhere, the elytral markings are also on a different plan. The three specimens are probably females, two of them are without longitudinal impressions on the abdomen, but the abdomen of the third is so shrivelled that its structure cannot be defined.

MONOLEPTA MEDIOFLAVA, n sp (Text-figs 44, 45)

♂—Flavous and black

Head with interocular groove short and straight, a triangular impression in front of its middle. Eyes large and prominent. Antennae long and moderately thin, second and third joints combined about the length of fourth. Prothorax almost twice as wide as long, sides rounded in front; median transverse impression rather shallow towards sides, interrupted in middle; punctures dense and rather

small, but sharply defined. Elytra rather narrow and subelliptic; punctures slightly larger than on prothorax, epipleurae very narrow at hind coxae. Abdomen with fourth segment incurved to middle, fifth with a medioapical impression, on each side of which is a narrow deep line. Basal joint of hind tarsi almost twice the length of the rest combined. Length, 4.25-4.5 mm.

♀—Differs in having the head and eyes slightly smaller, antennae shorter and thinner, fourth segment of abdomen straight at apex and fifth simple.

Hab—Queensland Brisbane (Blackburn's collection), Cairns district (F. P. Dodd and A. M. Lea), Kuranda (H. H. D. Griffith).

Structurally close to *M. peticollis* and colours much the same, but pattern very different, the elytral markings are somewhat as on *M. substriata*, but the prothorax also has markings, in Blackburn's table if referred to A, B B, it might be associated with *M. tepperi*, which is a very different species, if not with that species, a fresh section, C C C C, would be required for it. The flavous parts of the upper surface are the head, a bilobed spot at the base of the prothorax and the thickened front angles (on a female the base and lateral margins throughout), the scutellum and a wide sutural patch on elytra, the patch occupies the medio-basal third for a short distance, is then suddenly dilated to about the middle of each elytron, and is then narrowed to terminate near the apex, the three basal joints of antennae are pale and sometimes part of the fourth and base of the eleventh, the extreme base of the hind tarsi is black, on one male the outer margins of the elytra are narrowly pale beyond the basal fourth, and its head has a median dark line. The interocular space on the female is slightly less than the width of an eye, on the male it is distinctly less.

MONOLEPTA VITTIMEDIA, n. sp.

♂—Pale flavous; base of head, a median vitta on prothorax, scutellum, abdomen, inner margins of elytral epipleurae, most of antennae and extreme base of hind tarsi black or blackish, two apical joints of tarsi infuscated.

Head with interocular impression deep and almost straight, a triangular impression in front of its middle. Eyes large and prominent. Antennae long and thin, second and third joints combined about the length of fourth. Prothorax less than twice as wide as long, front angles rounded off, median transverse impression rather wide, not interrupted in middle; punctures somewhat irregular, but in places fairly dense and sharply defined. Elytra almost parallel-sided to near apex, with dense and rather small, sharply defined punctures, epipleurae very narrow at hind coxae. Apical segment of abdomen with two narrowly impressed lines. Basal joint of hind tarsi about one-third longer than the rest combined. Length, 3.25-3.5 mm.

♀—Differs in the usual particulars of head, eyes, antennae and abdomen.

Hab—Queensland National Park (H. Hacker), New South Wales Dorrigo (W. Heron), Mittagong (Dr. E. W. Ferguson).

In Blackburn's table this species could hardly be associated with *M. fumaticornis*, as the antennae are not entirely deep black, three or four of the basal joints being partly pale, it should therefore go with *M. dilutor*, from which, as also from *M. fumaticornis*, it is distinguished by the deep black median vitta of the pronotum, it is about the size and with the general appearance of *M. acaciae*, but that species has the suture narrowly dark, and the prothoracic vitta much narrower. The black part of the head extends about half way to the interocular groove. On three males the abdomen is entirely dark, on the only female only its apical segment is dark, on two Queensland specimens there is a faint red-

dening of the apex of elytra, probably indicating that on living specimens the colour there is brighter than the rest of the elytra

MONOLEPTA ABERRANS, n sp (Text-figs 46, 47)

Black and whitish-flavous

Head with a deep and slightly curved interocular groove, somewhat dilated in its middle. Eyes prominent but small. Antennae moderately stout and not very long, third joint slightly longer than second and slightly shorter than fourth. Prothorax scarcely one-fourth wider than long, sides moderately rounded, punctures minute but rather sharp. Elytra subelliptic, sides gently rounded, punctures rather small and sharply defined but not crowded, epipleurae narrow at hind coxae. Basal joint of hind tarsi about one-third shorter than the rest combined. Length, 3 mm

Hab—Queensland. Mount Tambourine, New South Wales. Dalmorton, Tamworth (A. M. Lea)

The comparatively long prothorax and third joint of antennae, and short hind tarsi, with the rather small eyes, are aberrant in the genus, and the elytral epipleurae, although very narrow at the hind coxae, are traceable to beyond the middle, the basal joint of the hind tarsi is rather wide, but the three specimens before me appear to be females, as the apical segment of the abdomen is without longitudinal impressions. The type (from Mount Tambourine) has the head, sides of prothorax (except the thickened front angles) and an elongated median spot, suture and sides of elytra, a spot on each side of base (joined to the suture and side) and an elongated median vitta on each, commencing at the basal third and deflected to join in with the side near apex, tip of abdomen, extreme base of hind tarsi, and all the claw joints black, the antennae have the apical and three basal joints pale, the others infuscated or black, the front femora and tibiae are rather dark in the middle, the middle ones less so. The Tamworth specimen has the median spot of the prothorax thin and faint, and the black median vitta on each elytron widely joined at its base and apex with the side (so that an elongated spot is enclosed), the tips and outer margins are narrowly pale, the infuscation of the front legs is faint and on the middle ones scarcely traceable, and five basal joints of its antennae are entirely pale. The specimen from Dalmorton resembles the type in the markings of the prothorax, but the Tamworth one in those of its elytra, all its femora are dark in the middle and the abdomen is dark, except for a median vitta on the four basal segments. On the type there is a small fovea on each side of the middle of the prothorax, apparently representing remnants of the transverse impression, but from the other specimens even these are absent.

Group 5. Prothorax and elytra entirely dark

MONOLEPTA USITATA, n sp

♂—Black, elytra deep blue or purplish-blue

Head with interocular groove slightly curved, a triangular impression in front of its middle. Eyes large and prominent. Antennae long and moderately thin, second and third joints combined about the length of fourth. Prothorax less than twice as wide as long, sides moderately rounded, median transverse impression distinct towards sides, almost absent in centre, punctures minute and inconspicuous. Elytra feebly dilated posteriorly, punctures dense, rather small and in parts rugose; epipleurae very narrow at hind coxae. Apical segment of

abdomen with two narrow, longitudinal impressions Basal joint of hind tarsi slightly longer than the rest combined Length, 4.4-5 mm

♀—Differs in the usual particulars of the head, eyes, antennae and abdomen

Hab—Queensland Cairns (E Allen, F P Dodd, H Hacker, No 52), Kuranda (G E Bryant)

In general appearance like *M germari*, but consistently larger, antennae stouter and prothorax black or dark reddish-brown, of the nine specimens under examination six have the prothorax not really black, although at first glance it appears to be so The knees and trochanters are usually the only parts of the legs that are reddish, but on one female the legs are entirely of a rather dingy brown On the male the interocular part of the head occupies slightly less than one-third of the width, on the female slightly more than one-third

MONOLEPTA PARVONIGRA, n sp

Black, antennae, knees and base of front tibiae flavous

Head with interocular groove straight, a small depression in front of its middle Eyes prominent but rather small Antennae rather long and thin, second and third joints combined somewhat shorter than fourth Prothorax about once and one half as wide as long, sides gently and evenly rounded, median transverse impression rather deep towards sides, interrupted in middle, punctures sparse and minute Elytra feebly dilated posteriorly, with fairly dense and small, rugose punctures, few of them sharply defined, epipleurae very narrow at hind coxae Basal joint of hind tarsi about one-fourth longer than the rest combined Length, 2.5-2.75 mm

Hab—Queensland Daruley Island (H Elgner)

Structurally close to *M germari*, but upper surface entirely black and antennae entirely pale, although the median joints are slightly darker than the others Of the two specimens taken by Mr Elgner one is certainly a female, the other has somewhat longer and stouter antennae and is probably a male, but the structure of its abdomen is not very evident, owing to postmortem contractions

MONOLEPTA SUBMETALLICA, n sp

Black, with a slight bronzy or greenish gloss, legs flavous, two apical joints of tarsi infuscated, antennae blackish, three basal joints and part of the fourth pale

Head with interocular groove deep and almost straight, a triangular impression in front of its middle Eyes moderately large Antennae long and thin, third joint slightly longer than second, their combined length slightly shorter than fourth Prothorax about one half wider than long, sides (for the genus) rather strongly rounded, flat and without transverse impression in middle, punctures dense and rather sharply defined Elytra rather thin, parallel-sided to near apex, punctures slightly larger than on prothorax, epipleurae scarcely traceable beyond hind coxae Basal joint of hind tarsi slightly shorter than the rest combined Length, 2.5-3 mm

Hab—Queensland Dalby (Mrs F H Hobler)

About the size of ordinary specimens of *M germari*, but flatter, black with a vague metallic gloss, femora and tibiae entirely pale, punctures stronger, and pronotum without a median transverse impression, *M quaesita*, to which it is structurally closer, is a somewhat larger species, with legs mostly dark Two females were sent by Mrs Hobler

MONOLEPTA DOLICHOGNATHA, n sp

♂—Black with a dark metalho-green gloss, head in front of eyes and legs flavous, two apical joints of antennae infuscated, antennae blackish, three basal joints paler, but first joint dark on its upper surface

Head with interocular groove moderately curved, sides touching hind margins of eyes, muzzle longer than usual. Eyes rather small, each only about half the width of the interocular space. Antennae rather long and thin, third joint longer and thinner than second, and slightly shorter than fourth. Prothorax about one half wider than long, sides moderately rounded and feebly notched near apex, very feebly transversely impressed in middle, punctures rather small but dense and sharply defined. Elytra rather thin, parallel-sided to near apex, with crowded and sharply defined punctures, slightly larger than on prothorax, epipleurae very narrow at hind coxae. Apical segment of abdomen with a medioapical fovea. Basal joint of hind tarsi about one half shorter than the rest combined. Length, 3 mm

Hab—Western Australia. Beverley (E F du Boulay)

With the general appearance of *M. quaesita*, but muzzle much longer, and prothoracic punctures much more sharply defined. The muzzle and third joint of antennae are longer than usual in the genus, and the hind tarsi are shorter, the spine at the apex of the hind tibiae is also unusually short.

MONOLEPTA OVATA, n sp

♂—Black, antennae, except three apical joints, knees, trochanters and parts of tarsi obscurely flavous or testaceous

Head small, interocular groove triangular, a narrow deep impression in front of its middle. Eyes large and prominent. Antennae thin and rather long, second and third joints combined slightly longer than fourth. Prothorax evenly convex, almost twice as wide as long, sides gently rounded, hind angles subdentate, without transverse median impression; punctures dense, rather small and sharply defined. Elytra somewhat dilated in middle, punctures slightly larger than on prothorax, epipleurae scarcely traceable beyond hind coxae. Apical segment of abdomen with two longitudinal impressions, and a mediobasal fovea. Basal joint of hind tarsi almost twice as long as the rest combined. Length, 2.5-3 mm

Hab—Queensland. Coen River (W D Dodd)

A small, ovate, rather convex species, with unusually large eyes, each of these being distinctly wider than the interocular space, structurally it is close to *M. terminalis*, but the prothorax and elytra are entirely dark. A female from Cairns (A M Lea) probably represents a variety of the species, it differs from the type in having the elytra deep blue, more of the antennae and legs infuscated, apical segment of abdomen simple, and eyes slightly smaller.

MONOLEPTA MEDIOFUSCA, n sp

♀—Black, antennae and legs flavous, in parts infuscated

Head with interocular groove moderately curved. Eyes large, each slightly narrower than the interocular space. Antennae long and thin, second and third joints combined slightly longer than fourth. Prothorax and elytra with outlines and convexity as in the preceding species, but with decidedly smaller punctures. Basal joint of hind tarsi twice as long as the rest combined. Length, 3.5 mm

Hab—Queensland. Cairns district (A M Lea)

Structurally close to the preceding species, but larger, median instead of

apical joints of antennae dark, legs paler and punctures smaller, those on the elytra of the present species being only as large as those on the prothorax of the preceding one. The two apical joints of antennae are conspicuously paler than the four preceding ones, the legs, the knees and front tibiae excepted, are rather lightly infuscated, but the extreme base of the hind tarsi is black

MONOLEPTA INFLATA, n sp

Deep purplish-blue, antennae (except parts of three basal joints), and legs (except knees and base of front tibiae) black

Head rather wide, interocular groove almost straight, a narrow impression in front of its middle. Antennae prominent but not very large. Antennae long and thin, second and third joints combined about equal to fourth. Prothorax fully twice as wide as long, sides gently rounded, without median transverse impression, punctures minute but rather sharply defined. Elytra distinctly dilated to near apex, greatest width slightly more than twice that of prothorax, punctures rather small but sharply defined, epipleurae very narrow at hind coxae. Basal joint of hind tarsi very little longer than the rest combined. Length, 3 mm

Hab—Queensland Kuranda (G. E. Bryant)

A deep blue species, like *M. jacobyni*, but elytra strongly dilated posteriorly, their greatest width being more than that of *M. ovata* and allied species, and more to the rear. The type has slightly longer antennae (they just pass the tips of the elytra) and larger eyes than on a second specimen, and is probably a male, but unfortunately its abdomen is missing.

CANDEZEA

As previously noted, it is somewhat doubtful whether this genus should be regarded as distinct from *Monolepta*, apparently the only distinction being in the elytral epipleurae. On many species of *Monolepta* these are very narrow at the hind coxae and are not traceable beyond the apex of the first abdominal segment, on others they are faintly traceable to the apex of the second or even of the third and fourth, occasionally they are narrow but traceable almost or quite to the suture, but to see them clearly it is usually necessary to place the specimen on its back. Although I follow Jacoby and Blackburn in placing several species with the epipleurae long in *Candezea*, it would be advisable for future workers to check descriptions of both genera before describing new Australian species of either. See also notes under *C. decipiens*

CANDEZEA STENOPLEURA, n sp

Flavous, antennal joints after the third partly black, inner base of elytral epipleurae very narrowly infuscated, third tarsal joint and claws infuscated

Head with interocular groove straight and not very deep, a narrow impression in front of its middle. Eyes rather large. Antennae long and thin, third joint distinctly longer than second, their combined length about equal to fourth. Prothorax twice as wide as long, sides moderately rounded, hind angles dentate, without transverse median impression, punctures dense, small and somewhat rugose. Elytra short, sides dilated posteriorly, greatest width almost twice that of prothorax, punctures dense and not very large but sharply defined, epipleurae narrow but traceable to apex. Basal joint of hind tarsi slightly longer than the rest combined. Length, 3.5-4 mm

Hab—Northern Territory Groote Eylandt (N B Tindale), Darwin (G E Bryant, G F Hill, No 314, and W K Hunt)

A small, compact species, in many respects near description of *Monolepta brevior*, but larger, three basal joints of antennae pale and the fourth and following joints with base pale, the dark portion increasing in each joint to the eleventh, but even that one pale at the base. As the epipleurae, although narrow, are traceable almost to the suture at the apex of the elytra, the species was referred to *Candezea* rather than to *Monolepta*, in general appearance it is rather close to *M cryptomela*. There are nine specimens before me, but I cannot find distinctly masculine characters on any of them.

CANDEZEA RUDIS, n sp

Flavous, abdomen and apex of elytra somewhat paler than adjacent parts.

Head with interocular groove straight, not very deep, and almost at base of eyes, a narrow impression in front of its middle. Eyes large. Antennae long and thin, second and third joints combined slightly longer than fourth. Prothorax not quite twice as wide as long, sides moderately rounded, without transverse median impression, punctures not very large but rather rough and crowded. Elytra somewhat dilated to beyond the middle, where the width is almost twice that of prothorax, punctures slightly larger and more sharply defined than on prothorax, but decreasing in size posteriorly, with faint traces of striation, epipleurae very narrow posteriorly but traceable almost to suture. Basal joint of hind tarsi slightly longer than the rest combined. Length, 3.25 mm.

Hab—Northern Queensland (Blackburn's collection)

In general appearance fairly close to *C stenopleura*, but antennae entirely pale and prothoracic punctures coarser, the epipleurae are much the same, except that their inner margins are not dark. The type is probably a female.

CANDEZEA PARVOPUNCTATA, n sp

Flavous, metasternum infuscated, elytral epipleurae and extreme base of hind tarsi infuscated or black.

Head with interocular groove slightly curved and not very deep, a narrow impression in front of its middle. Eyes large. Prothorax almost twice as wide as long, sides moderately rounded, all angles subdentate, without transverse median impression, punctures minute and inconspicuous. Elytra rather thin and parallel-sided to near apex, punctures sparse, small and rugose, epipleurae narrow beyond hind coxae but traceable almost to suture. Basal joint of hind tarsi about one half longer than the rest combined. Length, 5 mm.

Hab—Queensland Endeavour River

In general appearance somewhat like *C palmerstoni* on a small scale, but under surface pale, interocular groove narrower, elytral punctures less sharply defined and hind tarsi shorter. There is a small subfoveate impression on the head of the type towards the base, but it may be accidental, the antennae are broken but four joints being left, of these the third is distinctly longer than the second, and slightly shorter than the fourth.

CANDEZEA SETIPENNIS, n sp

♂- Reddish, eight apical joints of antennae and extreme base of hind tarsi black, two apical joints of tarsi infuscated. Elytra with short, dense, upright setae.

Head with interocular depression straight and fairly deep, a small impression

in front of its middle. Eyes prominent and rather large. Antennae long and rather thin, second and third joints combined about the length of fourth. Prothorax about once and one half as wide as long, sides feebly rounded, hind angles subdentate, median transverse impression rather deep and wide, narrowly interrupted in middle, punctures irregular and small, but in parts sharply defined. Elytra slightly dilated to beyond the middle, with dense, sharply defined punctures, epipleurae very narrow posteriorly, but traceable almost to suture. Apical segment of abdomen with two longitudinal impressions. Basal joint of hind tarsi slightly longer than the rest combined. Length, 4-5 mm.

♀—Differs in having the head and eyes smaller, antennae shorter, elytra somewhat wider, and abdomen with the fourth segment less incurved to middle, and fifth simple.

Hab—New South Wales. National Park, Mittagong (A. M. Lea).

Structurally and with clothing very similar to *C. lea*, but elytra entirely pale, and prothorax smaller. The eyes although large are so placed that, even in the male, their combined width is slightly less than the interocular space.

CANDEZEA SEMINIGRA, n sp. (Text-fig 48)

♂—Pale flavous, antennae and apical two-thirds of elytra black, abdomen about apex, tarsi and part of tibiae infuscated. Elytra densely clothed with rather short, erect, pale pubescence.

Head with interocular groove almost straight. Eyes prominent, but not very large. Antennae long and, for the genus, not very thin, third joint slightly longer and stouter than second, their combined length slightly greater than fourth, fifth slightly longer and stouter than the adjacent ones. Prothorax about once and one half as wide as long, sides feebly dilated to near apex, median transverse impression moderately deep, not enfeebled in middle, punctures rather small but mostly sharply defined. Elytra almost parallel-sided to near apex, with dense punctures of moderate size and in places rugose, epipleurae very narrow posteriorly, but traceable almost to suture. Apical segment of abdomen rather large, with two narrow, longitudinal impressions, beginning at apex. Basal joint of hind tarsi about one-third longer than the rest combined. Length, 3.5 mm.

Hab—Queensland. Mount Tambourine (A. M. Lea).

A pubescent species, about the size of *C. lea* and the preceding species, but antennae stouter, transverse impression of prothorax not interrupted, and base of elytra flavous instead of reddish.

CANDEZEA ZICZAC, n sp. (Text-figs 49, 50)

♂—Flavous or testaceous, upper surface with numerous blackish or infuscated markings, parts of antennae and knees infuscated, extreme base of hind tarsi black. Clothed all over with short, dense, depressed, pale pubescence, some longer hairs in addition on the elytra.

Head with interocular groove not very deep, some distinct punctures between it and base. Eyes large, at their widest each about the width of the interocular space. Antennae long and thin, second and third joints combined slightly longer than fourth. Prothorax more than twice as wide as long, a shallow depression towards each side, punctures dense, sharply defined and not very small. Elytra large, sides slightly dilated in middle, punctures slightly larger than on prothorax, epipleurae very narrow posteriorly but traceable almost to suture. Apical segment of abdomen large, with two narrow, longitudinal impressions. Basal joint of hind tarsi almost twice as long as the rest combined. Length, 4-5 mm.

♀—Differs in having the head and eyes smaller, antennae shorter, elytra slightly wider, and apical segment of abdomen smaller and simple.

Hab—Western Australia Cue (H W Brown), New South Wales Illawarra (H J Carter), Hastings River (T. G Sloane), Northern Queensland (Blackburn's collection)

A very distinct species with markings unlike those of any previously described species of the Australian *Galerucides*. The dark markings on the upper surface consist of a median line on the head, five spots on the pronotum, and four series of more or less zigzag transverse markings on the elytra, one at the base, one before the middle, one at the middle, and one subapical, in addition the tips and epipleurae are dark. On the antennae the second joint is dark, the fourth has the apical half pale, the following joints are pale at the apex, but to a decreasing extent, so that only the extreme tip of the tenth is pale.

CANDEZEA BIMACULINIGRA, n. sp. (Text-fig 51)

♂—Bright flavous-red, each elytron with a large, round, black spot at the apical third, tips of joints of antennae, after the third, and knees infuscated.

Head with interocular groove slightly curved. Eyes large and prominent. Antennae moderately long and rather stout, second and third joints very short. Their combined length distinctly shorter than fourth. Prothorax scarcely one-fourth wider than long, sides feebly rounded, all angles subdentate, with a faint median transverse impression, punctures dense and rather minute but sharply defined. Elytra almost parallel-sided to near apex, with dense and sharply defined punctures. Apical segment of abdomen with two narrow, longitudinal impressions. Basal joint of hind tarsi almost as long as the rest combined. Length, 4.5 mm.

Hab—North-Western Australia.

A very distinct species, the reddish colour is similar to that of *M. densa* and *M. dimidiata*.

CANDEZEA LATA, n. sp. (Text-fig 52)

Flavous and black

Head wide, flat in front; interocular groove arched slightly backwards in middle. Eyes large and prominent. Antennae long and thin, third joint distinctly longer than second, and combined with it slightly longer than fourth. Prothorax more than twice as wide as long, without trace of a median transverse impression, punctures sparse and minute. Elytra dilated posteriorly, greatest width about twice that of prothorax, punctures moderately dense, not very large but sharply defined; epipleurae very narrow but traceable to suture. Basal joint of hind tarsi about as long as the rest combined. Length, 3.25-4 mm.

Hab—Queensland Kuranda (G E Bryant), Cairns district (F P Dodd and A M Lea)

A short, wide species, without any close allies in Australia. The black parts are the antennae, apical three-fourths of elytra, metasternum and hind legs (except knees and coxae), the front and middle tarsi are also infuscated. The eyes are large, but, owing to the great width of the head, each is only about half the width of the interocular space. There are nine specimens under examination, but the abdomen is so shrivelled in all of them that sexual characters are not evident; on some, however, the antennae are slightly longer and stouter and the eyes slightly larger than on others, so they are probably males.

Var. Four specimens from the same localities and collectors and also with

the abdomen shrivelled, evidently belong to this species, but differ from typical specimens in having the elytra and abdomen entirely black

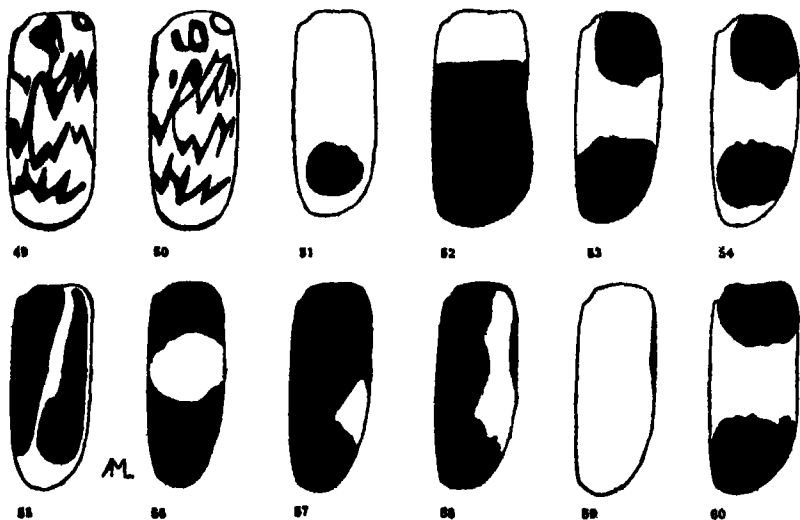
CANDEZEA DECIPiens, n sp

♀—Flavous, elytra black, metasternum and antennae after the third joint more or less infuscated

Head with interocular groove arched feebly backwards in middle. Eyes large and prominent. Antennae long and thin, third joint distinctly longer than second, the two combined slightly longer than fourth. Prothorax not twice as wide as long, hind angles rather strongly armed, without median transverse impression, punctures dense, small and sharply defined. Elytra almost parallel-sided to near apex, punctures somewhat larger than on prothorax, epipleurae very narrow at hind coxae but traceable to suture. Basal joint of hind tarsi about one half longer than the rest combined. Length, 4 mm

Hab—Queensland Cairns district (F P Dodd)

At first glance quite an ordinary looking species of *Monolepta*, but when



Text-figs 49-60 Elytral Patterns of species of *Candezea*

49-50 *C. zuzai* Lea 51 *C. bimaculinigra* Lea 52 *C. lata* Lea 53-54 *C. tetrastricta* Lea 55 *C. distincta* Lea 56 *C. maculipennis* Lea 57-59 *C. sculptipennis* Lea 60 *C. melanocera* Lea

laid on its back the epipleurae are narrowly traceable to the suture itself. From the described variety of the preceding species it differs in being thinner, antennae much thinner, hind tarsi longer, and scutellum, abdomen and all the femora pale. In general appearance the type is like an enlarged specimen of *Monolepta soror*, but the epipleurae are longer, the prothorax is without a median impression, the antennae are longer and paler, and the abdomen is entirely pale, from *M. abaceta* it also differs in being larger and in the epipleurae and abdomen, it is about the size of *M. pallidicollis*, but the head is pale, and antennae thinner, with the third joint decidedly longer in proportion. It is certainly congeneric with *M. ordinaria*, whose epipleurae, when examined from below or from the sides, may be seen to extend to the suture, although very narrow beyond the hind coxae (they were

described by Blackburn as "*pone medium obsoletus*"), but it differs from that species in having the eyes more frontal, the antennae longer and thinner, prothorax without median impression, and abdomen pale. I do not propose the transfer of *M. ordinaria* to *Candezea*, however, in view of the slight value of the latter genus.

CANDEZEA TETRASTICTA, n sp (Text-figs 53, 54)

♂—Flavous, elytra reddish, with four black spots, inner margins of elytral epipleurae, extreme basal of hind tarsi, and antennae, after the third joint, black.

Head with interocular groove narrow and slightly curved, a triangular impression in front of its middle. Eyes large and prominent. Antennae moderately long and thin, third joint distinctly longer than second, the two combined slightly longer than fourth. Prothorax fully twice as wide as long, sides gently rounded, hind angles dentate, median transverse impression feeble towards sides, still more feeble in middle, punctures irregular but usually sharply defined. Elytra sub-elliptic, with dense, sharply defined punctures of moderate size, epipleurae very narrow beyond hind coxae, but traceable to suture. Apical segment of abdomen with two longitudinal impressions. Basal joint of hind tarsi about half as long again as the rest combined. Length, 5.5 mm.

♀—Differs in having slightly smaller head and eyes, shorter antennae, slightly wider elytra and apical segment of abdomen smaller and simple.

Hab—Northern Territory. Darwin (G. F. Hill, No 206 and W. K. Hunt).

Generically distinct from *Aulacophora hilaris*, but with very similar elytral spots. On each elytron there is a large humeral spot extending to the basal third on the side, and to about one-fourth from the suture, the other spot is irregular on its anterior end and occupies the apical third, either entirely or leaving only the tip pale, on one specimen the two apical spots are narrowly separated at the suture, on three others they are widely conjoined there.

Var. One male has the upper surface of the elytra entirely reddish.

CANDEZEA INFEMICOLLIS, n sp

♂—Flavous, elytra and antennae black, head in front of interocular groove, and legs deeply infuscated. Length, 4.5 mm.

Hab—Northern Territory. Batchelor (G. F. Hill, No 59).

Structurally as described in the preceding species, except that the interocular groove is slightly deeper, prothorax with sides quite straight, except for the rounding of the front angles, and the hind angles not dentate. The female differs from the male in having the head, three basal joints of antennae, and legs pale, and in the usual characters of the eyes, antennae and abdomen.

CANDEZEA DISTINCTA, n sp (Text-fig 55)

Pale flavous, antennae, most of elytra, knees, tibiae (their median parts infuscated) and parts of tarsi black.

Head with interocular groove gently curved and moderately deep. Eyes rather large and prominent. Antennae long and thin, third joint almost twice the length of second, and not much shorter than fourth. Prothorax more than twice as wide as long, sides gently dilated to near apex, apex slightly incurved to middle, median transverse impression rather wide towards sides, interrupted in middle, punctures sparse and inconspicuous. Elytra parallel-sided to near apex, punctures sparse, mostly small, and not sharply defined, epipleurae traceable to suture. Basal joint of hind tarsi as long as the rest combined. Length, 4 mm.

Hab—Queensland. Cairns district (A. M. Lea).

The black parts of the elytra are in three divisions: one occupying the median two-thirds at the base, and gradually narrowed posteriorly to terminate suddenly near the apex, and one commencing rather narrowly on each shoulder and dilated posteriorly to terminate level with the sutural vitta, as a result the elytra have three black vittae and four pale ones, but the pale marginal ones are conspicuous only from the sides. In a good light the base of most of the antennal joints may be seen to be obscurely reddish, the comparatively long third one is aberrant in the allied genera. The epipleurae are distinct to well beyond the second segment of abdomen, and are narrowly traceable to the suture itself. The type is probably a male, but the tip of its abdomen is shrivelled.

CANDEZEA MACULIPENNIS, n. sp. (Text-fig. 56)

♂—Blood-red, elytra purplish-brown, somewhat paler about apex, a large antemedian flavous spot on each, the two combined to form a conspicuous fascia, antennae black, three basal joints more or less obscurely reddish, legs flavous, tibiae and tarsi partly or entirely black or infuscated.

Head rather small, interocular groove deep and straight, a narrow impression in front of its middle. Eyes large and prominent. Antennae thin, passing tips of elytra, second and third joints very short, combined not half the length of fourth. Prothorax more than twice as wide as long, sides feebly decreasing in width to apex, a shallow depression towards each side representing the median transverse impression, punctures dense, small and rugose. Elytra subelliptic, rather strongly convex, faintly shagreened and with rather dense subrugose punctures, epipleurae traceable to suture. Basal joint of hind tarsi almost twice as long as the rest combined. Length, 4.5 mm.

♀—Differs in having somewhat smaller eyes, antennae not quite extending to tips of elytra, the second and third joints longer, combined being slightly more than half the length of fourth, elytra slightly larger, and abdomen simple.

Hab—Queensland. Mount Tambourine (A. M. Lea), New South Wales. Dorrigo (W. Heron).

An isolated species. The abdomen of the male is curious and is alike on four specimens, although probably somewhat shrivelled, the middle of the four basal segments is flat and densely clothed, the sides rapidly sloping to the margins, the third and fourth are strongly incurved to the middle, the fifth is depressed below the others, has a shallow depression on each side, and a narrow groove on each side of the flat median third. The epipleurae are fairly distinct to the third abdominal segment, and narrowly traceable to the suture, the flavous parts of elytra have a speckled appearance owing to "waterlogging" of the punctures.

CANDEZEA AVICENNIAE, n. sp.

♂—Dull reddish-brown, muzzle, under surface, legs, antennae, and a spot on each elytron, of a rather dingy flavous.

Head with interocular groove shallow, traversed by a shallow median line, which terminates shortly in front of its middle, but is continuous to base, with fairly dense, but not sharp punctures. Eyes large and prominent. Antennae moderately long and thin, second and third joints combined almost the length of fourth. Prothorax slightly more than once and one half as wide as long, sides gently rounded in middle, all angles armed, a rather shallow median line, and a fairly wide transverse median impression, both rugose, punctures slightly larger than on head. Elytra feebly dilated in middle, punctures fairly dense, of moderate size, and mostly sharply defined, with faint traces of striation, epi-

pleurae very narrow but traceable to suture. Apical segment of abdomen large, with two deep, narrow, longitudinal impressions. Basal joint of hind tarsi slightly longer than the rest combined. Length, 5.5-6.5 mm.

♀—Differs in having smaller head and eyes, shorter antennae, apical segment of abdomen smaller and simple, and front and middle tarsi thinner, especially the basal joint.

Hab—New South Wales: Sydney and National Park, on mangroves, *Avicennia officinalis* (A. M. Lea), Queensland: Bribie Island (H. Hacker).

An unusually large species, which possibly should be referred to a new genus. The spot on each elytron is postmedian, sublateral, and about the size of an eye, the apex, suture and shoulders are also paler than the adjacent parts, but without the shades being sharply limited, the pronotum is almost black, but all its margins are sometimes narrowly pale, the tarsi and apical joints of antennae are sometimes slightly infuscated, the whole upper surface is finely shagreened. On the male each eye is almost the width of the interocular space. On the only female before me the general colour is paler than that of the male, and each shoulder is as pale as the postmedian spot and almost connected with it by a vittate extension, but its metasternum is deeply infuscated. The specimen from Bribie Island is mostly reddish, with a fairly large blackish patch, and the pale spot on each elytron sharply defined.

CANDEZEA SCULPTIPENNIS, n. sp. (Text-figs 57-59)

♂—Flavous, most of elytra and under surface dark reddish-brown.

Head with interocular groove curved and moderately deep, a shallow impression in front of and another behind its middle. Eyes large and prominent, each the width of the interocular space. Antennae moderately long, second and third joints combined the length of fourth. Prothorax almost twice as wide as long, sides gently rounded in middle, all angles subdentate; a depression towards each side representing the median transverse impression, punctures fairly dense and rather small. Elytra oblong-elliptic, punctures fairly dense but mostly rugose, a compound longitudinal depression on each, epipleurae very narrow but traceable almost to suture. Apical segment of abdomen large, an almost square apical depression, bounded on each side by a narrow, deep impression. Basal joint of hind tarsi distinctly longer than the rest combined. Length, 5.75-6 mm.

♀—Differs in having slightly smaller head and eyes, shorter and thinner antennae, somewhat larger punctures, and simple elytra and abdomen.

Hab—Queensland: Cairns district (E. Allen, H. Hacker, No. 65, and A. M. Lea).

Nearer the preceding than any previously described species, but more faintly shagreened, differently coloured, with smaller punctures, thinner antennae, prothoracic impressions different, and the male with curious elytra, the depression on each commences near the base, and extends along the middle for about the length of the metasternum, it is in three sections: a shallow almost circular opaque impression at each end, and a treble impression consisting of two outer opaque parts each about half the size of the terminal ones, and a deeper, shining, elliptic inner one. On the only male under examination each elytron has a lateral, postmedian, subtriangular whitish spot, about half the size of the prothorax, the suture and tips are paler than the adjacent parts but not flavous, on one female the lateromedian spot is much the same, but there is an adjacent vitta near it extending to the shoulder, on a second female there is a whitish irregular patch on each

side from the shoulder to near the apex, on two other females the elytra are pale, except for a narrow lateral strip on each side, about the length of the metasternum

CANDEZEA MELANOCERA, n sp (Text-fig 60)

Flavous, head, antennae, basal fourth (suture excepted) and apical two-fifths of elytra, tarsi, middle and hind tibiae, and apical segment of abdomen black

Head with a narrow straight groove connecting the hind edges of eyes. Eyes large and prominent, each about as wide as the interocular space. Antennae long, passing apex of elytra, second joint very short, third not much shorter than fourth, fifth wider, sixth and seventh still wider and densely clothed, the following joints slightly shorter and notably thinner. Prothorax almost twice as wide as long, sides gently rounded, hind angles subdentate, median transverse impression very feeble, punctures inconspicuous. Elytra almost parallel-sided to near apex, punctures minute and somewhat rugose, epipleurae narrowly traceable to suture. Basal joint of hind tarsi slightly longer than the rest combined. Length, 4 mm

Hab—Northern Territory Darwin (G. E. Bryant)

An aberrant species. The apical segment of the abdomen is without longitudinal impressions, so the type may be a female, despite the conspicuously wide median joints of its antennae. The markings are much like those of *C. tetrasticta* but are more extended, so that it would be fair to consider the elytra as black with a wide, pale, submedian fascia, narrowly extended along the suture both in front and behind.

AUSTRALIAN NEUROPTERA PART IV

By P ESBEN-PETERSEN, Silkeborg

(Communicated by W W Froggatt, F L S)

(Plates xlv-xlvi)

[Read 31st October, 1923]

The following descriptions and notes are based upon material of Myrmeleontidae from different sources. The collection of the State Entomologist, Mr W W Froggatt, Sydney, has thus time supplied me with many interesting specimens. The material received from Dr R J Tillyard, Chief of the Biological Department, Cawthron Institute, Nelson, contained a number of new species. Dr Guy A K Marshall, Director of the Imperial Bureau of Entomology, British Museum, has sent me a specimen of the new and very interesting *Dictyoleon nervosus*, and from Mr Tage Scheibel, Coolumb, Queensland, I have received much valuable material. Professor Dr Yngve Sjostedt, Stockholm Museum, has forwarded to me some interesting specimens from Dr E Mjoberg's Australian Expedition. Mr Herbert Campion, British Museum, has kindly furnished me with photos of some of Walker's Australian type-specimens, and he has also assisted me in comparing photos and drawings of Australian species with type-specimens kept in British Museum. Professor Dr G W Muller, Greifswald Museum, has been so kind as to allow me to re-describe and to take photos of Gerstaecker's type-specimens. To all these gentlemen I have to express my most sincere thanks.

In order to facilitate the study of the Australian Myrmeleontidae I give here re-descriptions and photos of Gerstaecker's species, not hitherto figured, and later on I hope also to be able to give re-descriptions and photos of Gerstaecker's types in the other families of the Australian Neuroptera.

COMPSOLEON

Banks, Trans Amer Ent Soc, xxix, 1913, p 223

To Banks's description should be added the following characters: In forewing Rs arises much before the level of the cubital fork. Anterior Banksian line present in both pairs of wings. 2A and 3A in forewing do not coalesce, but are connected by a short crossvein. Cu₂ in forewing sinuate and ends in Cu_{1P}. A few crossveins in the apical area of both pairs of wings. Hindwing a little shorter than forewing.

Genotype, *Compsoleon (Myrmeleon) occultus* Walker (Pl xlv, fig 1)

ADELOPECTRON, n. g.

Antennae long, slender, club conspicuous, pointed at apex. Vertex raised. Prothorax slender, longer than broad. Abdomen shorter than hindwing. Legs very slender, femora and tibiae of equal length, tibiae twice as long as tarsi. 1st tarsal joint as long as 2nd, 3rd and 4th united, 5th as long as 2nd and 3rd together, 3rd and 4th of equal length, and each of them shorter than 2nd. Claws long, slender and almost straight. Underside of 5th tarsal joint with short blackish bristles. No spurs. Forewing broadened towards pterostigma; apex acute, hindwing longer and more slender than forewing, apex strongly pointed. Costal crossveins simple. In forewing R_s arises much before cubital fork. Cubital fork rather open. Cu_2 slightly sinuate, ending in the middle of Cu_1 . 2A and 3A do not coalesce, but are connected by a crossvein. In hindwing R_s arises near base of wing (one crossvein before origin of R_s). A series of gradate crossveins in the apical area of both pairs of the wings.

Genotype, *Adelopteron testaceum*

This genus is nearly related to the foregoing, but it may be regarded as a more specialised one.

ADELOPECTRON TESTACEUM, n. sp. (Pl. xiv, fig. 2)

Slender. Face and palpi reddish-yellow, a dark indistinct cordiform spot below the antennae, and a narrow short transverse streak above the antennae. Vertex reddish-yellow, strongly raised and forwardly projecting. Along the front edge of the raised part a blackish streak. A blackish longitudinal median streak on the posterior part of vertex, on dorsum of thorax and on dorsum of 1st and 2nd abdominal segments. Antennae about as long as thorax, pale brown with yellowish annulations dorsally, yellowish ventrally, club black and flattened. Prothorax testaceous, about twice as long as broad, narrowed in front, and with rounded front angles, the lateral margins narrowly blackish. Meso- and meta-thorax with some few dark streaks or spots towards the sides. Venter of thorax testaceous with a pitchy brown streak below the base of the wings. Thorax with long white hairs or bristles, mingled with a few blackish ones on the dorsum. Abdomen testaceous, darker towards apex. Legs yellowish, with small blackish spots and with long whitish bristles and short blackish hairs. Fore femora pale brown with two longitudinal blackish brown streaks. Tibiae with a narrow blackish band at apex and another near base. Tibial spurs brownish towards apex. Venation of wings whitish with a few blackish streaks or bands. Some crossveins are blackish at their ends, and quite few are totally blackish (5 or 6 between R and R_s and 2 at the end of M and of Cu_1 , in the hindwing not so distinctly as in the forewing). All the veins and all the margins of wings with rather long pale hairs. Hind margins of the wings with short brown streaks, which are brownish haired. Forewing, 22 mm, hindwing, 23.5 mm.

One specimen, Darwin, N.T., 3.3.1916 (G. F. Hill leg.) Coll. Tillyard.

DENDROLEON AMABILIS.

Gerstaecker, Mitth. naturw. Vereins für Neuorp. und Rugen, 1885, p. 97—*Dendroleon lambda* Tillyard, Proc. Linn. Soc. N.S. Wales, 1916, 52, Pl. iii, fig. 7.

One ♂, Hay, N.S. Wales, 21.1.1914 (W. W. Froggatt leg.). Coll. Froggatt.

This species belongs to the genus *Dendroleon* sens. str. 2A and 3A in forewing do not coalesce, but are connected by a short crossvein. The male with a "pelote" at base of hindwing.

GLENOLEON BERTHOUDI

Tillyard, Proc Linn Soc N S Wales, 1916, 55, Pl iii, fig 8

One ♀ from Australia, but without indication of locality (Greifswald Museum)

This species has some likeness to *Glenoleon falsus* Walk and to *Gl meteoricus* Gerst; but it differs from both in having 2A and 3A in the forewing coalescing at a point.

GLENOLEON OSMYLOIDES

Gerstaecker Mitth naturw Vereins für Neuorp und Rügen, 1884, p 27.—

Glenoleon annulicornis Esb-Peters, Proc Linn Soc N S Wales, 1915, 72, Pl vi, fig 5, xii, fig 26

One ♀, Moree N S Wales, 1917 (W W. Froggatt leg.) Coll Froggatt

After having seen Gerstaecker's type-specimen I am sure that my species-name has to be placed amongst the synonyms

MONSEGA.

Navas, Ann Soc scient Bruxelles, 1914, xxxviii, p 248

This genus is nearly allied to *Glenoleon*, but it differs in having the hindwing a little longer than the forewing, in possessing the costal area of the forewing biareolate from near base to pterostigma, and in possessing the 1st tarsal joint longer than 5th 2A and 3A touch each other at a point The character given by Navas that the area between Cu₁ and Cu₂ in forewing is partly biareolate, cannot hold good, it is an individual character only

The genotype is *Moss reticulata* Navas, (*loc cit*, p 249) from Mittagong, N S Wales This species is, however, the same as *Glenoleon indecussus* Banks (Trans Amer Ent Soc, 1913, 225, Esben-Petersen, Proc Linn Soc N S Wales, 1915, 73, Pl xiii, fig 25) and therefore the name *reticulata* has to be dropped

PLATYLEON, n g

Legs rather long and slender Femora and tibiae of equal length 1st tarsal joint as long as 2nd and 3rd united, 5th the longest Spurs as long as 1st and 2nd tarsal joints united Prothorax subcylindrical, 1½ times longer than broad Abdomen (♀) shorter than the hindwing Fore- and hindwings of almost the same length, but forewings broader than hindwings Costal area of forewing broad and biareolate from near base to a little before pterostigma. Its arises before the level of cubital fork. Anterior Banksian line present in both pairs of wings 2A and 3A do not coalesce Cu₂ undulate and ending in Cu_{1p} Angle between Cu_{1a} and Cu_{1p} rather acute. One crossvein before origin of Rs in hindwing

Genotype. *Platyleon froggatti*

This genus much resembles *Monsega*, but differs as to the length of the hindwing, of the tarsal joints and of the spurs. The three genera *Glenoleon*, *Monsega* and *Platyleon* form a peculiar group within the Dendroleonini

PLATYLEON FROGGATTI, n sp (Pl xiv., fig. 3.)

Face and palpi yellowish, a broad black transverse band between the eyes, enclosing the insertions of the antennae. Vertex testaceous with a few indistinct dark spots. Antennae lost Prothorax blackish, with rounded front angles, a transverse furrow one-third from front margin, blackish haired, and with a few indistinct pale spots Meso- and metathorax blackish with some testaceous spots.

Abdomen blackish, with a row of pale spots at each side. Venter of abdomen testaceous. Subgenital plate large and conspicuous. Legs pale, apex of femora, tibiae and of 5th tarsal joint with a black ring. Membrane of wings hyaline, venation pale with black streaks. Apical areas with a series of crossveins. Markings sooty black. Forewing, 27 mm., hindwing, 25 mm., body, 20 mm.

One ♀, N S Wales, 20.12.1915 (W. W. Froggatt leg.) Coll. Froggatt.

I take the liberty to dedicate this handsome species to the State Entomologist, W. W. Froggatt, in honour of his great work in exploring the Australian insect-fauna.

CHRYSOLOPON PLACTATUS

Banks, Ann. Ent. Soc. Amer., 1910, 43. Esben-Petersen, Arkiv for Zoologi, Bd. XI, 1918, p. 6, fig. 1.

One ♂, Derby, 7468. Coll. Tillyard.

CHRATOLEPON MJOBERGI, n. sp. (Pl. xlv, fig. 4.)

Palpi yellowish. Face and mouthparts yellowish. A broad blackish band between the eyes, enclosing the insertions of the antennae; above this band a narrow yellowish transverse streak. Vertex blackish-brown. The two basal joints of antennae brown (the rest of antennae lost). Prothorax as long as (or a little longer than) broad, blackish, with a transverse furrow one-third from front margin, with a short pale median longitudinal streak anteriorly, and with two pale indistinct spots at each side; meso- and metathorax blackish. Abdomen short, black. Legs rather stout, brown, basal part and underside of femora yellowish; hind tibiae yellowish with a black ring at apex, hind tarsi yellowish, apex of 5th tarsal joint blackish. 1st tarsal joint as long as 2nd and 3rd joints united. 5th joint the longest. No spurs. Wings rather long and with acute apex. Membrane of forewing brownish with hyaline spots, and with a large central hyaline area in the disc, this area encloses a brown spot. Pterostigma brownish. Membrane of hindwing hyaline in the basal half, a broad blackish brown cross-band below pterostigma, apical part lactaceous. Basal two-fifths of costal area in forewing biateolate. Basal half of radial area with two or more rows of irregular cells. The area between the stem of Cu_1 and of Cu_2 contains also two or more rows of irregular cells. Anterior and posterior Banksian lines present in both pairs of wings; in the hindwing the posterior line is only indicated. Venation blackish, in the forewing with some whitish interruptions. Apical area of forewing with a few crossveins just beyond pterostigma, apical area of hindwing without crossveins. At base of hindwing a "pelote" in the male sex. Forewing, 22 mm.; hindwing, 21 mm., body, 18 mm.

One ♂, N W Australia, January (Dr E. Mjöberg leg.) Stockholm Museum.

The specimen of this peculiar species comes from the material brought home by Dr E. Mjöberg from his expedition to Australia, 1910-1913.

AUSTROGYMNOCNEMIA AUSTRALIS, n. sp. (Pl. xlv, fig. 5.)

Palpi and face yellowish. Tip of apical joint of labial and maxillary palpi bifurcate. Between eyes a blackish transverse band enclosing the insertions of the antennae. Vertex strongly raised, reddish-yellow, a blackish transversely placed line in front, three blackish spots at hind margin, and on top a transverse dark streak. Antennae dark brown, yellowish annulated; basal joint yellowish above; apical part of antennae lost. Prothorax as long as broad, blackish, with yellowish spots and with several irregular reddish-yellow streaks ending abruptly

Meso- and metathorax blackish with small reddish-yellow spots. Abdomen black, apical part of dorsum pale. Legs brown with long white hairs, hind tibiae and hind tarsal joints pale, and with a dark ring at apex. Femora, tibiae and tarsi of almost equal length. 1st tarsal joint of foreleg as long as 2nd and 3rd joints united, of hind legs hardly as long as 2nd and 3rd joints together, 5th tarsal joint a little longer than 1st joint. Spurs microscopic. Wings long and slender, acutely pointed at apex. Membrane hyaline, venation pale with black dots and streaks. Anterior and posterior Banksian lines present in both pairs of wings. Pterostigma reddish-yellow with a blackish spot internally. Costal area in both pairs of wings rather narrow, and with simple crossveins. Forewing, 21-22 mm, hindwing, 18-19 mm, body, 14-15 mm.

One ♀, Hay, N S Wales, 20.1.1916 (W. W. Froggatt leg.) (Coll. Froggatt). One ♀, N W Australia (Dr E. Mjöberg leg.) (Stockholm Museum).

This species has much likeness to *A. bipunctata* Esb.-P., but its more pointed wings and its narrower costal area of forewing with the simple costal veins separate it rather easily from that species.

AUSTROGYMNOCNEMIA PENTAGRAMMA (Pl. xiv, fig. 7)

Gerstaecker, Mitth. naturw. Vereins für Neuvoerp und Rügen 1884, 34.

Face yellowish. Palpi brownish-yellow. A black transverse band between the eyes, enclosing the insertions of the antennae. Vertex somewhat reddish-yellow with blackish spots. Antennae blackish-brown, narrowly yellowish, annulated, the club inconspicuous. Prothorax a little longer than broad, with rounded front angles and with a transverse furrow one-third from front margin, blackish-brown with five short longitudinal yellowish-red streaks along the front border, and with six along the posterior margin. Meso- and metathorax blackish-brown with pale spots, and with pale hind borders. Abdomen blackish; segments with narrow pale hind margin dorsally. Abdomen much shorter than hindwings. Legs pitchy brown. Underside of femora and a band near tip yellowish. Fore- and middle tibiae with two yellowish bands on their outer side, hind tibiae on their outer side yellowish, with the exception of a dark band at apex. Tarsal joints yellowish at their base. Legs short. Femora and tibiae of almost the same length, tarsi as long as two-thirds of tibiae. 1st tarsal joint a little longer than 5th. Venation whitish with numerous blackish streaks. Most crossveins blackish, in the forewing they are mostly brownish shaded. Pterostigma whitish with a large dark brown spot internally. Forewing, 25 mm, hindwing, 23 mm.

(Gerstaecker's type-specimen is from Peak Downs.)

AUSTROGYMNOCNEMIA TIPULARIA (Pl. xlv, fig. 6)

Gerstaecker, Mitth. naturw. Vereins für Neuvoerp und Rügen, 1885, 102.

Face and palpi yellowish-white, a shining blackish transverse band between the eyes, enclosing the insertions of the antennae. Above this band an ivory white narrow transverse streak. Vertex somewhat raised, reddish-brown, with indistinct darker spots. Along the eyes an ivory white narrow streak posteriorly. Antennae long and slender, brownish, and with rather broad whitish annulations. Club blackish, not annulated. Prothorax about twice as long as broad, with rounded front angles narrowly yellowish on margins, and with a broad transverse furrow one-third from anterior margin; reddish-brown with two longitudinal irregular pale streaks, and with a narrow pale line at each side close to the lateral blackish margin. Meso- and metathorax blackish with pale spots. Abdomen blackish, shorter than the hindwings, dorsum of 3rd, 4th and 5th

abdominal segments each with a yellowish spot near base and a smaller one in their middle. Legs very long and slender, yellowish. Apex of femora and two narrow longitudinal lines on their upperside pitchy brown. Apex of tibiae with a small brownish band, another brownish band near base of fore and middle tibiae. Fore tarsi, and the 3rd, 4th and 5th tarsal joints of middle and hind tibiae blackish-brown. Claws tiny, almost straight, and pale brown. Fore legs longer and slenderer than the two other pairs. Femora and tibiae of equal length. Fore tarsi very tiny and as long as fore tibiae. Middle and hind tarsi hardly as long as their tibiae. The tarsal joints of fore tarsus almost equal in length, 1st the longest and 4th the shortest. 4th joint of intermediate and hind tarsi much shorter than the other joints. Legs with long whitish bristles. Venation whitish with brown streaks. Several crossveins totally black. Pterostigma yellowish with a large brown spot internally. Forewing, 18.5 mm, hindwing, 17 mm.

Gerstaecker's type-specimen is from Peak Downs.

At present six species are known of the genus *Austrogymnocrnemis*, but *tipularia* Gerst. and *maculata* Till. form a peculiar group or sub-genus owing to the fact that 2A and 3A in forewing are not free, but are touching each other at one point.

NEOPTLECTRON

Navas, *Memorias*, Barcelona, xi, 1914, 115.

This genus is closely allied to *Protoplectron* Gerst. Costal area of forewing biareolate in its first third, the area between Cu₁ and posterior margin of hindwing is also biareolate. In *Protoplectron longitudinalis* Till. the same area in the hindwing is biareolate, but the costal area in the forewing of this species is biareolate in its basal three-fifths.

The genotype is *Neopt. inversum* Navas, (*loc. cit.*, 116, fig. 5, Vienna Museum).

I have examined and photographed the type-specimen (Pl. xlv, fig. 8).

STENOGYMNOCNEMIA, n. g.

Antennae long and slender, prothorax a little longer than broad. Legs long and slender, tibiae without spurs. Wings very long, narrow and with acute tips. Hindwing as long as forewing. In forewing Rs arises beyond the level of cubital fork. Cu₂ long and almost straight. 2A and 3A coalesce for some distance. In hindwing one crossvein before Rs. M₂ straight, parallel to the hind margin. Apical area in both pairs of wings with a series of crossveins. No Banksian lines.

Genotype, *Myrmeleon malus* (Pl. xlv, fig. 9), Walker, *Catalogue of Neuropterous Insects*, 1853, 393.

DISTOLEON SOMMOLENTUS (Pl. xlv, fig. 10)

Gerstaecker, *Mitth. naturw. Vereins für Neuorp und Rügen*, 1884, 13 — *Distoleon verticilis*, Banks, *Ann. Ent. Soc. Amer.*, 1910, 42, Esben-Petersen, *Arkiv för Zoologi*, Bd. xi, 1918, 14, Pl. 1, fig. 5 — *Formicoleon thoreyi*, Navas, *Revista Real Acad. Madrid*, 1914, 475, fig. 6.

A small series from Coolumb, Queensland, March, 1921 (Tage Scheibel leg.) Coll. Esben-Petersen.

I have compared the type-specimen of *sommoletus* with specimens of *audax* Walker from Java and Philippine Islands, but I cannot find any difference between the specimens.

FORMICALEO BREVIUSCULUS (Pl xlv, fig 11)

Myrmeleon brevisculus, Gerstaecker, Mitth naturw Vereins für Neuorp. und Rügen, 1885, 100 — *Formicaleo waterhousei*, Tillyard, Proc. Linn Soc N S Wales, 1916, 63, Pl v fig 14

Two specimens are present, but with some doubt I refer one of them to the Gerstaeckerian species

One ♀, Hay, N S Wales, 5.2.1911 (W. W. Froggatt leg.); Coll Froggatt
One ♀, Hay, 20.1.1916 (W. W. Froggatt leg.)

FORMICALEO SEPTUS (Pl xlv, fig 12)

Gerstaecker, Mitth naturw Vereins für Neuorp und Rügen, 1885, 91

Palpi, clypeus and labrum yellowish, vertex and the rest of the face blackish-brown with a narrow pale zigzag transverse line above the antennae and four pale spots posteriorly (the two median spots close to each other). Face with a dense whitish pilosity, and with a transverse row of long whitish hairs along the upper margin of clypeus. The antennae blackish-brown, narrowly annulated with yellowish, the club yellowish-brown, narrowly annulated with blackish. Antennae longer than the thorax. Thorax pitchy black. Prothorax with three pale longitudinal streaks, the median ones very narrow. Abdomen hardly as long as the hindwing, blackish, the segments with narrow pale hind margin dorsally, third and fourth segments with a yellowish-brown spot in their middle dorsally. Legs pale, fore and intermediate femora darker in their apical part, and hind femora with a dark band at apex. Tibiae with a dark band at apex. Third, fourth and apex of fifth tarsal joint black. Legs with numerous black spots, with whitish hairs and with blackish bristles. Venation yellowish-white with numerous dark streaks, several crossveins totally dark. Pterostigma whitish, with a dark spot internally. Forewing, 23 mm, hindwing, 22 mm.

Gerstaecker's type-specimen is from Peak Downs.

FORMICALEO CONGESTUS (Pl xlv, fig 13)

Myrmeleon congestus, Gerstaecker, Mitth naturw Vereins für Neuorp. und Rügen, 1885, 90

Palpi, labrum and clypeus yellowish-brown, vertex and the rest of face jet-black, not glossy. Antennae blackish-brown, narrowly annulated with yellowish. Thorax black. Prothorax broader than long, a transverse furrow one-third from the front margin, on the disc three irregular pale longitudinal streaks; front angles rounded and narrowly margined with yellowish. Abdomen shorter than hindwing, blackish, and the segments with very narrow pale hind border dorsally. 7th abdominal segment with a pale, rather large, triangular, and rather pointed subgenital plate ventrally. Legs rather short and stout, pitchy brown, whitish haired and with blackish bristles. Fore femora basally, hind tibiae dorsally and 1st tarsal joint basally whitish. 1st tarsal joint as long as 2nd and 3rd united; 5th joint the longest. Spurs somewhat curved, as long as 1st and 2nd joints together. Venation whitish with brown streaks. Most crossveins totally brown, and a large number of them in the apical half of the forewing brownish shaded. Pterostigma indistinct with a brownish spot internally. Forewing, 23 mm; hindwing, 22 mm.

Gerstaecker's type-specimen (♀) is from Peak Downs.

FORMICALEO HILLI, n.sp. (Pl xlv, fig 14.)

Palpi yellowish, face yellowish with a reddish longitudinal median streak and with a transversely placed row of long whitish hairs. Vertex and upper part of

face brown; on top two parallel elevated transverse ridges. Vertex with a short pale median streak posteriorly. Basal joint of antennae yellowish, second joint brown (the rest of antennae lost). Prothorax a little shorter than broad, brown, with a pale longitudinal median streak and with a transverse furrow one-third from anterior margin. Meso- and metathorax brown with an indistinct pale median line and with pale margins posteriorly. Abdomen brown, third and following segments with a broad yellowish ring anteriorly. Legs short and stout, dark brown, basal part of femora and hind tibiae yellowish. 1st tarsal joint short, but longer than each of 2nd, 3rd and 4th, 5th joint longer than 1st-4th joints united. Spurs strong and curved, almost as long as 1st-4th tarsal joints of forelegs, but only as long as 1st-2nd joints of hindlegs. Wings long, gradually broadened from base towards apex which is rather obtusely pointed, especially in forewings. Membrane hyaline. Venation pale, with dark dots and streaks. No Banksian lines. Apical area in both pairs of wings with a few crossveins. Pterostigma yellowish with a brown spot internally, this spot is very small in the hindwing. R_s arises almost in the middle of the forewing. Forewing, 28 mm, hindwing, 29 mm, body, 22 mm.

One ♀, Darwin (G. F. Hill leg.). Coll. Tillyard

ESCURA DIVERGENS. (Pl. xlv, fig. 15)

Navas, Revista Real Acad. Madrid, 1914, 468, fig. 3

The type-specimen, kept in Vienna Museum, is labelled "Australia"

HETEROTRIPON APICALIS, n. sp. (Pl. xlv, fig. 17)

Slender. Face and palpi yellowish. Vertex brown to below the insertions of the antennae, posterior angles of vertex and a narrow circle round each eye yellowish. Antennae as long as head and thorax together, brown with narrow yellowish sutures, strongly clavate, apex of club obtuse. Prothorax a little longer than broad, yellowish, with two brown longitudinal median streaks, separated only by a yellowish line, at the posterior angles a short brown narrow lateral streak. Meso- and metathorax dark brown with an irregular yellowish spot above the base of each wing. Abdomen blackish; each segment narrowly margined with yellowish dorsally; pleurae yellowish. Legs rather strong, yellowish, femora with long whitish bristles; tibiae with long blackish ones. Tip of 5th tarsal joint black. 1st tarsal joint longer than 2nd or 3rd, but shorter than 5th. Spurs almost straight and about as long as 1st, 2nd and 3rd tarsal joints united. Wings rather slender, with acute apex. Membrane quite hyaline. Venation whitish with exception of most of the longitudinal veins which have blackish streaks; costal crossveins and a few crossveins between R and R_s are partly blackish. Veins whitish haired; margins of wings blackish (late). Pterostigma yellowish-brown. A brown streak along the row of gradate veins in apical part of forewing. A few crossveins in apical area of both pairs of wings present. Posterior Banksian line in forewing indicated. 2A and 3A coalesce for some distance. Forewing, 22 mm.; hindwing, 21 mm., body, 17 mm.

One ♀, Cunderdin, W. A., February, 1914. Coll. Tillyard

HETEROTRIPON FULCRILLUS, n. sp. (Pl. xlv, fig. 18)

Head testaceous; above the antennae which are lost, an irregular blackish transverse band; on the top of vertex two oblong transversely placed brown spots. Prothorax as long as broad or a little longer, testaceous, with a brown longitudinal median streak, narrowed at the transverse furrow, and with a wide

brownish-black lateral streak posteriorly. Meso- and metathorax testaceous with three longitudinal irregular blackish streaks cut off abruptly. Abdomen brown (discoloured in the type-specimen). Legs rather short and stout, testaceous; tibiae hardly as long as femora, tarsi as long as tibiae. Basal tarsal joint as long as 2nd and 3rd together, 2nd, 3rd and 4th almost of equal length, 5th as long as 1st-4th united. Spurs almost straight, a little longer than 1st-3rd joints united. Wings long, narrow and with acute tips, membrane hyaline, venation whitish with a few dark dots and streaks, ground-colour of Sc and R strongly yellowish, the subcostal area tinged with yellow. Anterior Banksian line hardly indicated in the forewing, not present in hindwing, posterior Banksian line in forewing distinct. Apical area with a series of crossveins which are strongly shaded brownish in the forewing. Cu₁ in the forewing strongly dotted with brownish. The outer apical series of crossveins in both pairs of wings shaded brownish in their posterior part. Forewing, 23 mm, hindwing, 22 mm, body, 21 mm.

One ♀. Roebourne, W A., March, 1914. Coll. Tillyard.

MYRMELEON CROCICOLLIS

Gerstaecker, Mitth. naturw. Vereins für Neu-vorp. und Rugen, 1884, 30, Australia. -- *Myrmeleon loweri*, Tillyard, Proc. Linn. Soc. N.S. Wales, 1916, 65, Pl. vi, fig. 15.

Tillyard's species is the same as that of Gerstaecker.

One ♀. Roebourne, W. Australia, April, 1914. Coll. Tillyard.

MYRMELEON COMPTON

Gerstaecker, Mitth. naturw. Vereins für Neu-vorp. und Rugen, 1885, 94, Peak Downs. -- *Myrmeleon croceus*, Esben-Petersen, Arkiv för Zoologi, Bd. xi, 1918, 20, Pl. 2, fig. 1, Kimberley district.

I find now, after having seen the type-specimen of *compton*, that my *croceus* is the same.

The type-specimen is a mature one, and I give here some supplementary notes to my description. -- Antennae jet-black. Labrum blackish-brown. Vertex with two short yellowish longitudinal streaks posteriorly.

MYRMELEON NIGROMARGINATUS

Esben-Petersen, Proc. Linn. Soc. N.S. Wales, 1917, 200, Pl. xi, fig. 5, Arkiv för Zoologi, Bd. xi, 1918, 21.

One specimen from Roebourne, W. Australia, March, 1914. Coll. Tillyard.

DICTYLEON, n. g.

Antennae clavate, almost as long as head and thorax together. Prothorax broader than long. Abdomen (♀) shorter than hindwing. Legs rather short, femora, tibiae and tarsi of equal length, 1st tarsal joint as long as 2nd and 3rd united, 2nd, 3rd and 4th joints short, 5th joint as long as 2nd, 3rd and 4th united. Spurs tiny and almost straight, a little longer than 1st tarsal joint. Wings of almost equal breadth from base to pterostigma, tip of hindwing more acutely pointed than that of forewing. Hindwing narrower than forewing. Costal area of forewing broad, three rows of cells from near base to a little before pterostigma, one series of cells in costal area of hindwing. Apical area of both pairs of wings with several irregularly placed crossveins. In forewing R₅ arises a little beyond the level of cubital fork, cubital fork very acute. Cu₂ long,

almost straight, its apical part running close to the hindmargin of the wing 2A and 3A coalesce for a very long distance In the hindwing Rs arises further out than the level of median fork Median fork very acute 1A very short and inconspicuous; 2A hardly visible Venation of wings very dense Posterior Banksian lines present

Genotype, the species described below

DICTYOLEON NERVOSUS, n sp (Pl xlv, fig 18)

Face yellowish Palpi brownish-black with yellowish sutures Between eyes a transverse blackish shining band, enclosing the insertions of the antennae. Vertex somewhat raised, testaceous, its top with numerous small tubercles, along anterior margin a transverse row of two blackish median spots and two laterally placed blackish streaks, along hind margin another row, containing two blackish triangular median spots and two pairs of laterally placed parallel blackish streaks Antennae brownish with paler sutures, club darker, first and second antennal joints blackish shining, dorsum of first joint yellowish Prothorax brown, with rounded front angles, lateral margins and front angles narrowly margined with yellowish, a narrow yellowish longitudinal median line and a broader indistinct yellowish streak between the median line and the lateral margins Meso- and metathorax brown, with paler spots and streaks above and below Abdomen brown, paler below, the abdominal segments with a large yellowish triangular spot at the front margin dorsally Tip of abdomen below with a blackish subgenital plate, strongly blackish haired, behind the plate a pair of blackish and strongly haired prolongations Legs of moderate size, femora yellowish, blackish towards tip, middle part of tibiae, especially of hind tibiae, yellowish, apex of tarsal joints dark Wings without markings Membrane hyaline Venation whitish with numerous blackish streaks Pterostigma whitish, in forewing with an indistinct blackish spot internally Forewing, 31 mm., hindwing, 31 mm; body, 21 mm

One ♀, Fiji Islands, 1 9 22 (H W Simmonds leg.) Imperial Bureau of Entomology, British Museum I consider this species to represent a peculiarly specialised group within the Myrmeleontini.

List of hitherto described species of Myrmeleontidae from Australia.

Where an asterisk has been put before a name I have seen material of the species.

I ARCHAEOMYRMELONIDA.

Espen-Petersen, *Entomologiske Meddelelser*, København, xii, 1918, 100; xiii, 1920, 194.

Stilbopteryx

Newman, *Entom Mag*, v., 1838, 399, v.d. Weele, *Cat Coll. Selys*, Ascalaphiden, 1908, 21.

1. *costalis*, Newman, *loc. cit.*, p. 400, v.d. Weele, *loc cit*, p 22, Tillyard, *Proc Linn Soc. N.S. Wales*, 1916, 69.
- *2. *napoleo* Lefebvre, Guérin, *Mag. Zool.*, 1842, 10, pl. 92, ♂; *dromedaria*, Tillyard, *loc. cit*, 1916, 67, figs. 1, 2, 3
3. *linearis*, Navas, *Entom Rundschau*, 1911. 12, fig. 1.

II. NEOMYRMELONIDA.

Espen-Petersen, *loc cit.*, 1918, 100; 1920, 194.

Periclystus.

Gerstaecker, Mitt. naturw. Vereins Neuorpom und Rugen, 1887, 103; Esben-Petersen, Proc. Linn. Soc. N.S. Wales, 1915, 67

- *1 *circuter*, Walker, Cat. Neur. Ins. Brit. Mus., 1853, 400, Esben-Petersen, *loc. cit.*, 1915, 68, Pl. x, fig. 17, (*callipeplus* Gerstaecker, *loc. cit.*, 1887, 107)
- *2 *lucratius*, Gerstaecker, *loc. cit.*, 1887, 105, Esben-Petersen, *loc. cit.*, 1915, 68, Pl. x, fig. 18
- *3 *aureolatus*, Tillyard, *loc. cit.*, 1916, 50, Pl. II, fig. 3.

Froggattisca

Esben-Petersen, *loc. cit.*, 1915, 64

- *1 *pulchella*, Esben-Petersen, *loc. cit.*, 1915, 65, Pl. ix., fig. 14

Dendroleon.

Brauer, Novara-Expedition, Neuroptera, 1866, 42, Esben-Petersen, *loc. cit.*, 1915, 70

- *1 *amabilis*, Gerstaecker, *loc. cit.*, 1885, 97, (*lambda* Tillyard, *loc. cit.*, 1916, 52, Pl. III, fig. 7)
- *2 *longipennis*, Esben-Petersen, *loc. cit.*, 1915, 70, Pl. XI, fig. 20
- 3 *dumigani*, Tillyard, *loc. cit.*, 1916, 53, Pl. III, fig. 6

Glenaleon

Banks, Trans. Amer. Ent. Soc., 1913, 223, Esben-Petersen, *loc. cit.*, 1915, 71, Arkiv för Zoologi, Vol. XI, 1918, 7

- *1 *pulchellus*, Rambur, Hist. nat. Ins. Neuroptères, 1842, 408
- *2 *falsus*, Walker, Cat. Neur. Ins. Brit. Mus., 1853, 303, Esben-Petersen, Proc. Linn. Soc. N.S. Wales, 1915, 73, Pl. XI, fig. 21.
- *3 *meteoricus*, Gerstaecker, *loc. cit.*, 1884, 25; Esben-Petersen, *loc. cit.*, 1915, 73, Pl. XII, fig. 22
- *4 *dissolutus*, Gerstaecker, *loc. cit.*, 1884, 26, Esben-Petersen, *loc. cit.*, 1915, 73, Pl. XII, fig. 23.
- *5 *osmylodes*, Gerstaecker, *loc. cit.*, 1884, 27; (*annulicornis* Esben-Petersen, *loc. cit.*, 1915, 72, Pl. VI, fig. 5; Pl. XIII, fig. 26)
- 6 *stigmatus*, Banks, Ann. Ent. Soc. Amer., 1910, 40, Trans. Amer. Ent. Soc., 1913, 224
- *7 *radialis*, Banks, *loc. cit.*, 1913, 224, Esben-Petersen, *loc. cit.*, 1915, 72, Pl. XII, fig. 24
- *8 *berthoudi*, Tillyard, *loc. cit.*, 1916, 55, Pl. III, fig. 8
- *9 *aurora*, Tillyard, *loc. cit.*, 1916, 56, Pl. IV, fig. 9.
- 10 *roseipennis*, Tillyard, *loc. cit.*, 1916, 57
- *11 *annulatus*, Esben-Petersen, Arkiv för Zoologi, XI, 1918, 7, Pl. I, fig. 2

Glenurus.

Hagen, Stett. ent. Zeitung, 1866, 372.

- 1 *bicarunculatus*, Brauer, Verh. zool.-bot. Gesellsch., 1868, 186 Pelew Islands

Mosoga.

Navas, Ann. Soc. scient. Brux., XXVII, 1914, 248

- *1. *undecima* Banks, Trans. Amer. Ent. Soc., 1913, 225, Esben-Petersen, Proc. Linn. Soc. N.S. Wales, 1915, 73, Pl. XII, fig. 25, (*reticulata* Navas, *loc. cit.*, 1914, 248).

Platyleon, n g

- *1 *fraggatti*, n sp.

Chrysolson

Banks, Ann Ent Soc Amer, 1910, 43, Esben-Petersen, Arkiv for Zoologi, xi, 1918, 5

- *1. *punctatus*, Banks, loc cit., 1910, 43; Esben-Petersen, loc cit., 1918, 6, fig 1

Ceratolson.

Esben-Petersen, Proc. Linn. Soc. N.S. Wales, 1917, 207

- *1 *brevicornis*, Esben-Petersen, loc. cit., 1917, 207, Pl x, fig 3. Pl xi, fig. 3A

- *2 *mjobergi*, n sp.

Austrogymnocnema.

Esben-Petersen, loc cit., 1917, 206

- *1 *bipunctata*, Esben-Petersen, loc cit., 1915, 63, Pl vi, fig 3, Pl ix, fig 13
 *2 *pentagramma*, Gerstaecker, loc cit., 1884, 34
 *3 *tipularia*, Gerstaecker, loc cit., 1885, 102
 *4. *interrupta*, Esben-Petersen, loc cit., 1915, 64, Pl vi, fig 4, Pl viii, fig 12.
 5 *maculata*, Tillyard, loc cit., 1916, 57, Pl iv, fig 11
 *6 *australis*, n sp.

Anomaloplectron

Esben-Petersen, Arkiv for Zoologi, xi., 1918, 8

- *1 *lineatipenne*, Esben-Petersen, loc cit., 1918, 9, Pl. i, fig 3

Acanthoplectron

Esben-Petersen, loc cit., 1918, 10

- *1 *tenellum*, Esben-Petersen, loc cit., 1918, 11, Pl i, fig 4

Compsoleon

Banks, Trans. Amer Ent Soc., xxiv, 1913, 223

- 1 *ocellatus*, Walker, Cat Neur Ins. Brit Mus., 1853, 386, Banks, loc cit., 1913, 223

Adeloplectron, n g

- *1. *testaceum*, n sp.

Protoplectron

Gerstaecker, loc cit., 1884, 15, Banks, Ann Ent Soc Amer, iii, 1910, 40, Esben-Petersen, Proc Linn Soc N.S. Wales, 1915, 66; 1917, 204.

- *1. *venustum*, Gerstaecker, loc cit., 1884, 16; Esben-Petersen, loc cit., 1915, 66, Pl ix, fig 15, (*phcatum* Navas, Revista Real Acad, Madrid, 1914, 466, fig 2).
 *2 *pallidum*, Banks, Ann Ent. Soc Amer., 1910, 41, Esben-Petersen, Arkiv for Zoologi, xi., 1918, 11.
 3. *eremiac*, Tillyard, loc. cit., 1916, 49, Pl ii, fig. 4
 *4. *striatellum*, Esben-Petersen, Proc Linn Soc N.S. Wales, 1917, 204, Pl x, fig. 1.
 *5. *gerstaeckeri*, Esben-Petersen, Arkiv for Zoologi, xi., 1918, 11, Pl. i., fig 6.

Neoplectron.

Navas, Memorias, Barcelona, xi., 1914, 115.

- *1. *incertum*, Navas, loc. cit., 116, fig. 5.
 2. *longitudinale*, Tillyard, loc. cit., 1916, 48, Pl. ii., fig. 5.

Pseudoformicaleo

vd Weele, Notes Leyden Mus., xxi, 1909, 25, Esben-Petersen, Proc Linn. Soc N S Wales, 1915, 67, 1917, 204

- *1 *nubeculus*, Gerstaecker, *loc cit*, 1885, 101. (= *jacobsoni*, vd Weele, *loc cit*, 1909, 25, Pl II fig 8, *costatus* Banks, Ann Ent Soc. Amer., 1910, 41, *caligatus*, Navas, Revue Russe d'Ent., 1912, 113, *ignobilis*, Navas, Memorias, 1914, 115, *aesthenicus*, Navas, Insecta, 1914, 140)

Mjöbergia

Esben-Petersen, Arkiv för Zoologi, xi, 1918, 18

- *1 *fulviguttata*, Esben-Petersen, *loc cit*, 1918, 13, Pl I, fig 7

Macronemurus

Costa, Fauna Napol Myrm., II, 1855, 8

- 1 *abditus*, Walker, Catalogue, 1853, 360

Stenoqymnocnemia, n g

- 1 *malus* Walker, Catalogue, 1853, 395

Eidoleon

Esben-Petersen, Arkiv för Zoologi, xi, 1918, 15

- *1 *histrigatus*, Rambur, Hist nat Ins Névroptères, 1842, 391½ (*striola*, Walker, Catalogue, 1853, 340, *perjurus*, Walker, *loc cit*, 340, *tornus*, Walker, *loc cit*, 341, *violentus*, Walker, *loc cit*, 348)
- *2 *mgrognatus*, Tillyard, *loc cit*, 1916, 64, Pl vi, fig 17, Esben-Petersen, Arkiv för Zoologi, xi, 1918 15

Distoleon

Banks, Ann Ent Soc Amer., III, 1910, 40, Esben-Petersen, *loc cit*, 1918, 15

- *1 *sommolentus*, Gerstaecker, *loc cit*, 1884, 13. (*verticalis*, Banks, *loc cit*, 42, Esben-Petersen, *loc cit*, 1918, 14, Pl. I, fig 5, *thoreyi*, Navas, Rev Real Acad Madrid, 1914, 475, fig 6)
- 2 *nefarius*, Navas, Revue Russe d'Entom., x, 1910, 190, Australia.

Formicaleo

Leach, Edinb Encycl., ix, 1815, 138

- *1 *bremiusculus*, Gerstaecker, *loc cit*, 1885, 100; (*waterhousesi*, Tillyard, *loc cit*, 1916, 63, Pl v, fig 14)
- *2 *sepius*, Gerstaecker, *loc cit*, 1885, 91
- *3 *congestus*, Gerstaecker, *loc cit*, 1885, 99
- 4 *wilsoni*, MacLachlan, Ann Mag Nat Hist, x, 1892, 178 Hawaiian Islands
- 5 *desperus*, Banks, Ann Ent Soc Amer., III, 1910, 43
- 6 *subpunctulatus*, Brauer, Verh zool-bot. Gesellsch., 1869, 16. Fiji Islands
- 7 *vaffer*, Walker, Catalogue, 1853, 345; (*desperatus*, Walker, *ibid*, 359; MacLachlan, Journ. Linn. Soc Lond., 1869, 278, *permiosus*, Walker, *loc cit*, 360 (without locality), MacLachlan, *loc cit*, 278, *malefidus*, Walker, *loc cit*, 364, MacLachlan, *loc cit*, 278)
- 8 *insomnis*, Walker, *loc cit*, 384 (without locality, Australia ?)
- *9 *camfrons*, Navas, Rev Real Acad. Madrid, 1914, 473, fig 5; Esben-Petersen, Proc Linn Soc N.S. Wales, 1917, 208, Pl xi, fig. 4.
- 10 *ballivi*, Navas, *loc cit*, 1914, 475 Honolulu

- 11 *hyalinus*, Tillyard, *loc cit.*, 1916, 62, Pl. vi, fig. 16.
 *12. *hili*, n. sp.

Escura.

- Navas, *loc cit.*, 1914, 468, (*Alloformicaleon*, Esben-Petersen, *loc cit.*, 1915, 69)
 *1 *divergens*, Navas, *loc cit.*, 1914, 468, fig. 3
 *2 *australis*, Esben-Petersen, *loc cit.*, 1915, 69, Pl. vi, fig. 6, Pl. xi, fig. 19.

Brachyleon

- Tillyard, *loc cit.*, 1916, 58.
 *1 *durum*, Tillyard, *loc cit.*, 1916, 59, Pl. ix, fig. 10.

Heteroleon.

- Esben-Petersen. Arkiv för Zoologi, xi, 1918, 16
 *1 *erilis*, Esben-Petersen, *loc cit.*, 1918, 16, Pl. iii, fig. 1
 *2 *marginalis*, Banks, Ann. Ent. Soc. Amer., 1910, 44, Esben-Petersen, *loc cit.*, 1918, 17, Pl. ii, fig. 2
 *3 *apicalis*, n. sp.
 *4 *pulchellus*, n. sp.

Neleus

- Navas. Broteria, 1912, 31
 1 *striatus*, Navas, Rev. Real Acad. Madrid, 1914, 471, fig. 4

Stenoleon

- Tillyard, *loc cit.*, 1916, 60
 1 *peltis*, Tillyard, *loc cit.*, 1916, 60, Pl. v, fig. 13

Xantholeon

- Tillyard, *loc cit.*, 1916, 61
 *1 *helmsi*, Tillyard, *loc cit.*, 1916, 61, Pl. v, fig. 12

Myrmeleonellus

- Esben-Petersen. Arkiv för Zoologi, xi, 1918, 17
 *1 *pallidus*, Esben-Petersen, *loc cit.*, 1918, 18, Pl. ii, fig. 3

Leptoleon

- Esben-Petersen, *loc cit.*, 1918, 18
 *1 *regularis*, Esben-Petersen, *loc cit.*, 1918, 19, Pl. iii, fig. 3.

Myrmeleon

- Linné, Syst. Nat., xii, 913
 1 *acer*, Walker, Catalogue, 1853, 348, (*solens*, Walker, *ibid.*, 367, *mopinus*, Walker, *ibid.*, 368; *malignus*, Walker, *ibid.*, 380, *hostilis*, Walker, *ibid.*, 384, *ersangus*, Walker, *ibid.*, 388, MacLachlan, Tijdschr. voor Entom., xiii, 1875, 7).
 *2 *croceicollis*, Gerstaecker, *loc cit.*, 1884, 30, *loweri*, Tillyard, *loc cit.*, 1916, 65, Pl. vi, fig. 15; Esben-Petersen. Arkiv för Zoologi, xi, 1918, 21
 *3. *comptus*, Gerstaecker, *loc cit.*, 1885, 94, (*croceus*, Esben-Petersen, *loc cit.*, 1918, 20, Pl. ii, 1).
 *4 *unicornatus*, Gerstaecker, *loc cit.*, 1884, 29
 *5 *pictifrons*, Gerstaecker, *loc cit.*, 1885, 96; Tillyard, *loc cit.*, 1917, 544
 *6 *diminutus*, Esben-Petersen. Proc. Linn. Soc. N.S. Wales, 1915, 62, Pl. vi, fig. 2, Pl. viii, fig. 11.
 *7. *ugromarginatus*, Esben-Petersen, *loc cit.*, 1917, 209, Pl. xi, fig. 5, Arkiv för Zoologi, xi, 1918, 21.
 8. *neocaledonicus*, Navas, Memorias, 1912, 391 New Caledonia.

Dictyoleon, n. g.

- *1 *nervosus*, n. sp. Fiji Islands

Callistoleon

Banks, Ann Ent Soc Amer, iii, 1910, 42, Esben-Petersen, Proc Linn Soc. N S Wales, 1915, 62

- *1 *erythrocephalus*, Leach, Zool Miscell. i., 70, Pl xxx; Esben-Petersen, Arkiv för Zoologi, xi, 1918, 21, Pl iii, fig 2, (*guttatus*, Rambur, Hist nat Ins Neuroptères, 1842, 409, MacLachlan, Ann Soc Ent Belg, 1873, 140)
- *2 *illustris*, Gerstaecker, loc cit, 1885, 92, 1887, 111, Esben-Petersen, Proc Linn Soc N S Wales, 1915, 62, Pl viii, fig 10

W. celeus

Navas, Memorias, 1912, 172

- 1 *acutus*, Walker, Catalogue, 377, Navas, loc cit, 1912, 173, fig 18 New Zealand

Mestressa

Navas, Rev Real Acad Madrid, 1914, 464

- *1 *subfasciata*, Banks, Proc Ent. Soc Wash, 1913, 141, Esben-Petersen, Proc Linn Soc N S Wales, 1915, 60, Pl xiii, fig 27, Arkiv for Zoologi, xi, 1918, 22, Pl iii fig 5, (*maesa* Navas, loc cit, 464, fig 1)

Acanthachilus

Rambur, Hist nat Ins Neuroptères, 1842, 378

- *1 *fundata* Walker, Catalogue, 320, Esben-Petersen, Proc Linn Soc. N S. Wales, 1915, 61, Pl viii, fig 8, Arkiv for Zoologi, xi, 1918, 22.
- *2 *subtendens* Walker, Catalogue, 321, Esben-Petersen, Proc Linn Soc. N S. Wales, 1915, 61, Pl vii, fig 7, Arkiv for Zoologi, xi, 1918, 22; (**conspurcata*, Gerstaecker, loc cit, 1885, 88)
- *3 *fulva*, Esben-Petersen, Entom Mitteil., 1912, 209, fig 3, Proc Linn Soc. N S. Wales, 1915, 60, Tillyard, *ibid*, 1916, 67
- 4 *peterseni*, Tillyard, Proc Linn Soc N S Wales, 1916, 66, Pl i, fig. 2.

Cosina.

Navas, Broteria, 1912, 47, Esben-Petersen, Proc Linn Soc. N S Wales, 1917, 210, Arkiv for Zoologi, xi, 1918, 22

- *1 *maculachlanii*, v d Weele, Notes Leyden Mus, xiv, 1904, 210, Navas, Broteria, 1912, 47, Esben-Petersen, Arkiv for Zoologi, xi, 1918, 23, Pl. iii, fig 6.

2 *neozelandica*, Navas, Memorias, 1912, 108 New Zealand

3 *vaga*, Navas, Ann Soc scient Brux., 1914, 231, locality unknown

- *4 *annulata*, Esben-Petersen, Proc. Linn Soc N S Wales, 1915, 59, Pl vii, fig 1, Pl vii, fig 9

- *5 *maculata*, Esben-Petersen, Arkiv för Zoologi, xi, 1918, 23, Pl iii, fig. 4

Uncertain species

Myrmeleon tigrinus, Fabricius, Syst Ent p 312. Australia

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 ———— *Proc. Ent. Soc. Wash.*, xv., 1913.
 ———— *Trans Amer. Ent. Soc.*, xxxix., 1913
 ———— *Acad Nat. Sc Philadelphia*, 1914.
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 ———— New Genera and Species of Neuropterous Insects, and a revision of F Walker's British Museum Catalogue of Neuroptera *Journ Linn Soc Lond.*, ix, 1867
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 ———— Supplementary Note on the Neuroptera of the Hawaiian Islands *Ann Mag Nat Hist.*, x, 1892
 NAVAS, L.—*Broteria.* Vol x, Zoologica, fasc 1 and n, 1912
 ———— *Memorias Real Acad Barcelona*, x, 1912
 ———— *Ann Soc sc Bruxelles*, 1914
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 PERKINS, R C L.—*Fauna Hawaeniensis. Neuroptera* 1899
 RAMBUR—*Histoire naturelle des Insectes Névroptères* (1842)
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 ———— *Odonata, Planipennia, and Trichoptera from Lul Howe and Norfolk Islands.* *Ibid*, 1917.
 ———— *Studies in Australian Neuroptera,* v. *Proc Linn Soc N S. Wales*, 1918.
 WALKER—*Catalogue of Neuropterous Insects in British Museum* (1853).

EXPLANATION OF PLATES XLV-XLVI

Plate xlv

1. *Comptosia occultus* Walk Type Brit. Mus
2. *Adelopteron testaceum*, n.sp. Type. Coll. Tillyard.
3. *Platyleon froggatti*, n.sp. ♀ Type. Coll. Froggatt
4. *Ceratoleon mjobergi*, n.sp. ♂ Type Stockholm Mus
5. *Austrogymnocranius australis*, n.sp. ♀ Cotype. Stockholm Mus.
6. *Austrogymnocranius tipularia* Gerst. Type. Greifswald Mus.
7. *Austrogymnocranius pentagramma* Gerst. Type. Greifswald Mus
8. *Neopteron inversum* Navas. Type. Vienna Mus

Plate xlv

- 9 *Stenogymnocrania malus* Walk. Type Brit Mus
- 10 *Distoleon somnolentus* Gerst Type Greifswald Mus.
- 11 *Formicaleo brevisculus* Gerst Type Greifswald Mus
- 12 *Formicaleo septus* Gerst Type Greifswald Mus
- 13 *Formicaleo congestus* Gerst Type Greifswald Mus
- 14 *Formicaleo hilli*, n sp ♀ Type Coll Tillyard
- 15 *Iscura divergens* Navas Type * Vienna Mus
- 16 *Heteroleon pulchellus*, n sp ♀ Type Coll Tillyard
- 17 *Heteroleon apicalis* n sp ♀ Type Coll Tillyard
- 18 *Dictyleon nervosus*, n sp Type Imperial Bureau of Ent., Brit Mus

AUSTRALIAN NEUROPTERA PART V.

By P. ESBEN-PETERSEN, Silkeborg

(Communicated by W. W. Froggatt, F.L.S.)

(Plate XLVII.)

[Read 31st October, 1923.]

These notes, concerning the Australian Mantispid fauna, are mostly based upon material belonging to the State Entomologist, Mr W. W. Froggatt, Sydney, and to Dr R. J. Tillyard, chief of the Biological Department, Cawthron Institute. I wish here to express my best thanks to these two gentlemen for their kindness in allowing me to examine the very interesting material. My thanks are also due to Professor Krüger, Zoological Museum, Greifswald, for the opportunity given me to examine and to take photos of the Gerstaeckerian type-specimens.

Amongst the forms belonging to the Australian fauna, the genera *Ditaxis*, *Calomantispa* and *Theristria* may be looked upon as the most archaic, they are less specialised than *Euchmaecia*, *Mantispa*, *Campion*, etc. In the three first-named genera M arises close to the base of the wings, and in the forewing the stem of M does not touch or coalesce with R further out; in the genus *Calomantispa*, however, the stem coalesces with the basal part of R_a for a short distance. In the forewing of *Euchmaecia*, *Mantispa* and others, M arises also close to the base, but its stem coalesces with R for a long distance a little further out. In these genera M has a very irregular course in the forewing.

DITAXIS BISERIATA.

Mantispa biseriata, Westwood, Trans. Ent. Soc. Lond., 1852, 263, Pl. xvii., fig. 7.—*Ditaxis biseriata*, MacLachlan, Journ. Linn. Soc. Lond., 1867, 262.

Coll. Froggatt: One specimen, Tweed Heads, N.S. Wales, 18.10.1901 (Froggatt leg.). Coll. Esben-Petersen: One ♂, Buhmba, October, 1916; one ♀, Brisbane (ex Coll. Tillyard).

This genus, including the single species, is closely allied to the South American genus *Drepanicus*. In both genera the pterostigmatic area possesses crossveins, and Sc is only connected with R by two crossveins, one near base and one behind the pterostigma. M is running free of R. In *Ditaxis* R_a arises further out, and M, Cu, 1A and 2A are forked in a less degree than in *Drepanicus*. Both genera possess two series of gradate crossveins.

CALOMANTISPA SPECTABILIS var. PICTA.

Calomantispa picta, Stitz, Mitt. Zool. Mus. Berlin, 1913, 46, fig. 40.

Coll. Froggatt: One ♀, Koorawatha, N.S. Wales, 30.7.1902 (H. Brown leg.).

In my own collection I possess one specimen of Banks' type series and one species of his var. *maculata*, determined by himself

The colour of Froggatt's specimen is still darker than in *picta* Stitz Thorax is quite black with the exception of a triangular vermilion spot on prothorax dorsally and also of a narrow short vermilion streak along the hind border of mesothorax The sides and venter of thorax quite black Abdomen black, the dorsum of two segments vermilion Legs black, front femora with two yellowish spots below, front tibiae with a narrow yellowish band at base, and a yellowish spot near apex dorsally The sanguineous coloured part of forewing has a still greater extension towards the apex than in *picta*, only the apical fourth of the hind margin is hyaline Expanse of forewings 27 mm

The specimen (♀) recorded by Stitz is from N S Wales *Calomantispa spectabilis* seems to be a species very liable to vary

Theristria delicatula.

Montispa delicatula, Westwood, Trans Ent Soc Lond, 1852, 261, Pl xvii, fig. 5—Adelaide—*Theristria felina*, Gerstaecker, Mitt naturw Vereins fur Neuorp und Rugen, 1884, 44—Peak Downs, Esben-Petersen, Proc Linn Soc. N S Wales, 1914, 643, Pl lxxv, fig 11—Cape York

Coll Froggatt One ♀, Koorawatha, 30 4 1902, one ♂, Snowy R, January, 1909, one ♀, Mt. Magnet, W Australia, 14 12 1904, one ♂, Witton, 15 12 1891, one specimen (without abdomen) Merriwa, N S Wales, 1904 (Froggatt leg), one specimen (abdomen lost) Coonamble, N S Wales (Froggatt leg) Coll Tillyard One ♂, Magnaxiel, N Queensland, 9 4 1911, one ♀, Cunderdin, 21 2 13 Coll Esben-Petersen One ♂, one ♀, Victoria (ex Coll Hauschild) Greifswald Museum One ♂, Peak Downs (Type-specimen of *Theristria felina*)

The type-specimen (♂) of *Theristria felina* has lost its hindwings, and is rather immature, but as far as I can see, it is the same as *delicatula* Westwood. The markings on vertex are very indistinct, the abdominal markings, however, agree very well with the figure given by Westwood The anal appendages of the type are the same as in the male specimens, seen by me, and the tarsal claw of intermediate and hind tarsi has a small dent near apex as shown by Westwood

Theristria delicatula varies to some extent Mature specimens agree well with the description given by Westwood, but the three small spots between the antennae are often absent, and sometimes a narrow black longitudinal median line is present on the face In fully matured specimens the femora and the front coxae are totally black the four hind tibiae have a blackish band at base and a narrow one at tip, the pterostigma is totally dark brown. The length of the radial cells in the forewing varies in a high degree, and the number of branches from the radial sector is also rather inconstant A good and distinct character not mentioned by Gerstaecker is the dark spot on the hind margin of the forewing close to the base

Theristria eurysticta (Plate xlvii, fig 1)

Gerstaecker, Mitt naturw Vereins fur Neuorpom und Rugen, 1885, 105—Sydney and Rockhampton

The face yellowish-brown, with an impressed brown slender lateral line below each antenna Vertex yellowish-brown, raised as in *delicatula*, and with some irregular dark brown spots and streaks Antennae slender, and brown with paler sutures, the two basal joints paler Prothorax as in *delicatula* Meso- and meta-thorax greyish-brown with paler median band and sutures Abdomen reddish

brown with darker hind borders of the segments. Legs pale greyish-brown, indication of a very narrow median band on intermediate and hind tibiae. Claws of middle and hind tarsi cleft at apex. Venation pale, crossveins blackish. End of branches from R_s blackish, R_s itself also blackish, where it emits its branches. Where the blackish crossveins touch the main veins small blackish streaks are present. The forks along the border of the wings dark at base. Pterostigma uniformly coloured, pale brown. Subgenital plate longer than upper appendages; these are deeply cleft. Forewing, 18 mm, hindwing, 15 mm.

Greifswald Museum. One ♂, type-specimen.

The specimen seems to be somewhat immature, and at first sight I thought it to be the same as the foregoing species. I have not seen any specimen like it.

Theristria dimcolor

Mantispa discolor, Westwood, Trans. Ent. Soc. Lond., 1852, 262, Pl. xvii, fig. 6.

(Coll. Esben-Petersen, two ♂, Victoria (ex Coll. Hauschild).)

There is one other described species in the genus, viz. *Theristria hillebrandi* Navas (Memorias, 1914, 98) but I do not know it.

Campioniella bellina

Navas, Bol. Soc. Aragonesa Cienc. Nat., 1914, 65, fig. 1—Sydney.

Coll. Esben-Petersen, two ♀, Victoria (ex Coll. Hauschild).

With regard to the venation of the wings this genus is closely allied to *Euclimacia*, but it differs in its rather long and slender prothorax and antennae. In the forewing 1A and 2A are both forked. The genus includes only this species.

Euclimacia nuchalis

Mantispa nuchalis, Gerstaecker, Mitt. naturw. Vereins. Neuvorp. und. Rugen, 1884, 38—Sydney and Rockhampton, Esben-Petersen, Arkiv för Zoologi, xi, 1917, 13—*Euclimacia torquata*, Navas, Mem. Real Acad. Barcelona, 1914, 95, fig. 10—Queensland.

Greifswald Museum. One specimen (type). Hamburg Museum. One specimen.

Head reddish-yellow. Palpi a little darker, a blackish narrow transverse band encloses the insertion of the antennae. Antennae reddish-yellow, 46-jointed, all the antennal joints from the third very short. Prothorax short, about twice as long as broad in front; a deep transverse furrow one-third from front margin; the part in front of the furrow strongly broadened towards tip, at each side of the furrow a tubercle, hind part of prothorax cylindrical. Prothorax reddish-yellow, the furrow and the extreme base blackish. Meso- and metathorax reddish-brown; abdomen brownish-red, the abdominal segments with very narrow paler sutures. Fore coxae and femora dark reddish-brown with dark streaks and spots, middle and hind femora reddish-brown. Tibiae and tarsi yellowish. Venation yellowish-brown; along the fore border a strong yellowish tinge. Forewing, 20 mm; hindwing, 17 mm.

Mantispa erythraea

Brauer, Verhandl. zool.-bot. Gesellsch., 1867, 506, Esben-Petersen, Archiv für Zoologi, xi, 1917, 12; Proc. Linn. Soc. N.S. Wales, 1917, 218, Pl. xv, fig. 14—*Euclimacia erythraea*, Stötz, Mitt. Zool. Mus. Berlin, 1913, 42.

Hamburg Museum: Two specimens, Brisbane (type-specimens); Coll. Froggatt: One ♀, Northern Rivers, N.S. Wales, 1914 (Dodd leg.).

The species is easily recognised by the broad strongly yellowish band along

vertex, thorax and abdomen, on the abdomen the band is interrupted by blackish transverse streaks. The basal cell between the stem of Cu and 1A in the forewing obscure and pale brown coloured. Along the hind angle of forewing a brown obscure streak.

MANTISPA PICTIVENTRIS (Plate xlvii, fig 4)

Gerstaecker, Verhandl naturw Vereins Neuorp und Rugen, 1885, 103 —
Mantispa tillyardi, Esben-Petersen, Proc Linn Soc N S Wales, 1914, 642, Pl
 lxxv, fig. 10

Greifswald Museum One ♂, Rockhampton (type-specimen of *pictiventris*)
 Coll Tillyard One ♂, Cuballing (type-specimen of *tillyardi*) Coll Froggatt
 One ♂, Melbourne, 1906 (Froggatt leg), one ♀, Tasmania (Simson leg), one ♀,
 Armadale, N S Wales, 27 2 1900 (Froggatt leg) Coll Esben-Petersen One
 ♀, Victoria (ex Hauschild)

Head yellowish-brown with a black crossband above the antennae, between the band and the eyes a narrow yellowish band. Between and below the eyes a narrow short black stripe. Antennae reddish-brown with short and broad joints; all the antennal joints with the exception of the basal three shorter than broad; underside of the two basal joints yellowish. Prothorax two and a half times as long as broad in front, dark greyish-brown above, reddish-yellow below. Meso- and metathorax reddish-yellow with rather broad dark brown longitudinal median band. Abdomen dorsally jet-black with a narrow whitish-yellow streak at each side and with pale pleurae, underside pale, with numerous small blackish dots. Legs brownish-yellow, innerside of fore femora with two brownish indistinct spots. Venation brown, Sc and R in forewing partly paler. Pterostigma sanguineous.

The species varies to some extent in the colour of the head, the legs and the veins, the number of branches from Rs is inconstant.

In two of the specimens here mentioned 1A in the forewing has a small fork.

Isla verendus Navas is probably described on a specimen of *M pictiventris* with somewhat aberrant venation.

I am much inclined to consider *M. pictiventris* as a synonym of *M australiae* Guérin, but as I have not seen the type of the latter or seen specimens compared and agreeing with Westwood's series in British Museum, I do not like to decide upon the matter.

MANTISPA TENUISTRIGA (Plate xlvii, fig 5)

Gerstaecker, Mitt naturw Vereins Neuorp und Rügen, 1884, 42

Greifswald Museum One ♀, Rockhampton (type-specimen).

Face yellowish-brown, vertex a little darker. Antennae pale brown, becoming darker towards apex, the antennal joints are longer and narrower than in *pictiventris*, 3rd joint almost twice as long as broad, 4th-8th joints as long as broad. Prothorax two and a half times longer than broad in front, pale brown, and with a blackish lateral streak, which does not reach the front or the hind margin. Meso- and metathorax yellowish-brown, with reddish-brown median streak. Abdomen reddish-yellow above, with a rather broad brownish-black lateral streak, venter pale. Legs yellowish-brown, fore femora interiorly with brownish-black. Venation brown. Pterostigma dark sanguineous. Forewing, 14 mm.; hindwing, 12.5 mm.

This species is very like *pictiventris*, but its longer antennal joints and the different coloured thorax and abdomen separate the two species rather easily.

MANTISPA VITTATA.

Guérin, Voy Coquille, Insectes, p 196; Westwood, Trans Ent Soc. Lond, 1852, 257, Pl xvii., fig 1.

Coll Froggatt Five specimens, Moree, N.S. Wales (Froggatt leg.), one specimen, Melbourne, 2 specimens, Brewarrina (Froggatt leg.); one specimen, Stradbroke Is., 19 2 1910 Coll Tillyard Two ♂, Hobart (G H Hardy leg.), one ♂, one ♀, Hobart (Tillyard leg.), two ♀, Triabunna (G H Hardy leg.), two ♀, Hampton (Tillyard leg.), one ♀, Mt Tambourine (W H Davidson leg.); one ♀, Cunderdin, one ♀, Landfield (Tillyard leg) Coll Esben-Petersen One specimen, Wynyard, two specimens, Victoria (ex Coll Hauschild), two specimens, Port Darwin (ex Coll Banks).

This species is very variable The expanse of the forewings differs, in the material before me, from 15 mm to 28 mm The colour of the pterostigma changes from yellowish-red to dark brownish-red The large dark spot on the front femora interiorly is often divided in a small apical spot and a larger median spot The most constant character is to be found in the slender and dull prothorax, which is finely transversely striated, finely granulose and shortly haired The vertex and the occiput are not glossy, but granulose and haired There is much variation in the number of branches from Ra

MANTISPA STRIGIPES. (Plate xlvii, fig 6)

Westwood, Trans Ent Soc Lond, 1852, 259, Pl xvii, fig 3.—*Mantispa pavida*, Gerstaecker, Mitt. naturw Vereins Neuorp. und Rügen, 1884, 41

Coll Tillyard One specimen, Brisbane Greifswald Museum One ♀, Rockhampton (type-specimen of *pavida*)

This species is very like the foregoing, but its vertex and prothorax are glossy and not granulose or haired The base of forewings is suffused with yellowish-brown, which is also shown by Westwood in his figure of the species

I consider *M pavida* to be synonymous with *strigipes* Gerstaecker's type-specimen is rather immature The brownish shaded basal part of forewing is hardly so strongly coloured as in mature specimens The colour of veins and of pterostigma is also paler.

AUSTROMANTISPA IMBECILLA (Plate xlvii, fig 7)

Mantispa imbecilla, Gerstaecker, Mitt naturw Vereins Neuorp und Rügen, 1884, 41 —*Mantispa pullula*, Banks, Psyche, xvii, 1910, 104 —*Necyla doddi*, Navas, Rev. Real Acad Madrid, 1914, 651 —*Austromantispa imbecilla*, Esben-Petersen, Arkiv för Zoologi, xi, 1917, 11; xii, 1918, 34 (sep).

Coll. Tillyard. One specimen, Darwin (G. F. Hill leg.); one specimen, Landsborough, (bred 19.10.1915), one specimen, Hornsby (bred 21.2.1917) Coll. Esben-Petersen. One specimen, Herberton; one specimen, Port Darwin (one of Banks' type-series of *pullula*) Stockholm Museum Five specimens, Queensland; one specimen, N.W. Australia. Greifswald Museum One specimen, Rockhampton (type-specimen)

Face yellowish, labrum pale brown; a longitudinal median narrow black streak starting from the brown spot above the antennae. Vertex yellowish with a large brownish spot, enclosing a smaller oblong yellowish one. Antennae blackish; the two basal joints brown with yellowish underside. Prothorax long and slender, four times as long as broad in front, finely granulose, each granule provided with a short black hair; brownish-yellow; near front margin a brown spot at each side and two short longitudinal streaks in middle. Meso- and metathorax brown with

yellowish longitudinal median band. Abdomen reddish-yellow, with a brown band at each side, most segments with narrow dark margin posteriorly. Legs brownish-yellow, fore femora dark brown interiorly, and with indistinct brownish spots exteriorly. Venation blackish-brown. R in forewing and Sc in hindwing paler. Pterostigma short and reddish-brown.

This description is made from the type-specimen. In *Arkiv for Zoologi*, xi, 1917, p. 11 (sep.) I proposed the subgenus *Austromantispa* to include all species in which the pterostigma is very short, almost triangular. Costa outside the pterostigma is strongly convex. Sc and C coalesce about at the origin of R, Rs with few branches.

AUSTROMANTISPA MANCA (Plate xlvii, fig 8)

Mantispa manca, Gerstaecker. *Mitt naturw Vereins Neuvorp und Rugen*, 1884, 39—Amboina—*M manca papuana*, Weele, *Notes Leyden Mus*, xxxi, 1909, 92—Dutch New Guinea—*Mantispa manca*, Stitz, *Mitt Zool Mus Berlin*, vii, 1913, 10—German New Guinea.

Coll Tillyard. One ♂, Brisbane. Coll Esben-Petersen. One ♀, Philippine Islands. Greifswald Museum. One ♀, Amboina (type-specimen).

The type-specimen is not quite mature, but below I give a short description of it.

Head pale brown, an oblong spot on labrum, another on face and a smaller one between the antennae, which are lost. Vertex with a pale cross-shaped marking. Prothorax slender, yellowish, five times longer than broad in front. Front fourth brown enclosing two obliquely-placed pale spots, two brown bands on basal half. Meso- and metathorax reddish-yellow, with darker spots. Abdomen blackish (dark brown) and brownish-yellow marbled. Legs brownish-yellow. Fore coxae with three rather indistinct brownish bands, fore femora with three bands (or three brown spots interiorly and exteriorly). Fore tibiae with an indistinct brown band in the middle and at tip. Venation pale brown. C, Sc and R pale. Pterostigma dark reddish-brown. Forewing, 12.5 mm, hindwing, 11 mm.

I was much surprised to see this interesting species from Australia. The base of forewings in my specimen from Philippine Islands is suffused with yellowish-brown. The heart-shaped elevation between and above the antennae and the peculiar short and almost triangular pterostigma offer good characters in recognising the species. The apical margin of the pterostigma is straight and forms almost a right angle to the costa. Antennae yellowish, the second joint brown in its apical half, an annulus (8 joints) in their middle blackish, and their tip (8 joints) also blackish. Front coxae and the four hind legs dark banded. The two small tubercles behind the dilated front part of the long and slender prothorax very conspicuous.

List of species of Australian Mantispidae

Where an asterisk has been put before a species, I have seen material of it.

Ditaxis

MacLachlan, *Journ Linn Soc Lond*, ix, 1867, 262.

- *1 *biseriata*, Westwood, *Trans Ent Soc Lond*, 1852, 263, Pl. xvii., fig 7; Enderlein, *Stett ent Zeit*, 1910, 379.

Calomantispa

Banks, *Trans Amer Ent Soc*, xxxix, 1913, 209.

- *1 *spectabilis*, Banks, *loc. cit.*, 210. Esben-Petersen, *Proc Linn Soc. N S. Wales*, 1914, 645, Pl. lxxv. fig 12.

var nigrita, Banks, *loc cit.*, 210

var maculata, Banks, *loc cit.*, 210

pecta, Stitz, Mitt Zool Mus. Berlin, vii, 1913, 45, fig 40

Theristria

Gerstaecker, Mitt naturw Vereins for Neuorp und Rugen, 1884, 43.

- *1 *dehcatula*, Westwood, *loc cit.*, 1852, 261; Pl xvii, fig 5 (*felina*, Gerstaecker, *loc. cit.*, 1884, 44; Esben-Petersen, Proc. Linn Soc. N S Wales, 1914, 643, Pl. lxxv, fig 11)
- *2 *discolor*, Westwood, *loc cit.*, 262, Pl xvii, fig 6
- *3. *eurysticta*, Gerstaecker, *loc cit.*, 1885, 105
- 4 *hillebrandi*, Navas Memorias, Barcelona, 1914, 98, fig 13

Campion

Navas, Bol Soc Aragonesa Cienc Nat, 1914, 65

- *1 *rubellus*, Navas, *loc.*, 1914, 65, fig 1

Euchmacia

Enderlein, Stett ent. Zeit, 1910, 362.

- *1 *nuchalis*, Gerstaecker, *loc cit.*, 1884, 38, Esben-Petersen, Arkiv för Zoologi, xi, 1917, 13 (sep) (*torquata*, Navas, Memorias Real Acad. Barcelona, 1914, 95, fig 10)
- *2 *flavicosata*, Esben-Petersen, Proc Linn Soc N S Wales, 1917, 217, Pl. xv, fig 13

Isla

Navas, Revista Real Acad, Madrid, 1914, 652

- 1. *verendus*, Navas, *loc.*, 652, fig 4

Mantispa

Illiger, Verz Kater Preussens, 1798, 499

- 1 *australasiae*, Guérin, Icon Règne Animal Insectes, 1829-38, 392, Westwood, Trans Ent Soc Lond, 1852, 258, Pl xvii, fig 2
- *2 *vittata*, Guérin, Voy Coquille, Insectes, 196, Westwood, *loc cit.*, 257, Pl. xvii, fig 1
- *3 *strigipes*, Westwood, *ibid.*, 259, Pl xvii, fig 3 (*pavida*, Gerstaecker, *loc. cit.*, 1884, 41)
- 4 *soutellaria*, Westwood, *loc cit.*, 260, Pl xvii, fig 4
- *5 *erythrara*, Brauer, Verh zool-bot Gesell Wien, xvii, 1867, 506, Esben-Petersen, Proc Linn Soc N S. Wales, 1917, 218, Pl xv, fig. 14; Arkiv for Zoologi, xi, 1917, 12
- *6 *tenuistriga*, Gerstaecker, *loc cit.*, 1884, 42.
- *7 *pictiventris*, Gerstaecker, *loc cit.*, 1885, 103 (*tillyarda*, Esben-Petersen, Proc Linn Soc N S Wales, 1914, 642, Pl lxxv, fig 10)
- 8. *platycephala*, Stitz, Mitt Zool Mus Berlin, vii, 1913, 26, fig 22—Yorktown
- 9 *chrysops*, Stitz, *ibid.*, 27, fig 23—Tasmania.
- 10. *crucifera*, Navas, Bol Soc. Aragonesa, 1914, 61—Tasmania.
- 11 *hamichroa*, Navas, Rev Real Acad Madrid, 1914, 490—Australia.
- 12. *ovulosa*, Navas, *ibid.*, 648—Grahamstown (New Zealand ?)
- 13. *impressa*, Navas, *ibid.*, 649, fig. 2—Tasmania.
- 14 *verticalis* Banks, Bull Mus Comp. Zool., lxiv., 1920, 339, Pl. vi, fig 75—Australia.

Austromantispa.

Esben-Petersen, Arkiv for Zoologi, xi., 1917, 11 (sep.)

- *1 *imbecilla*, Gerstaecker, *loc cit.*, 1884, 41 (*pullula*, Banks, Psyche, xvii., 1910, 104, *dodda*, Navas, Rev Real Acad Madrid, 1914, 651)
- *2 *manca*, Gerstaecker, *loc cit.*, 1884, 39

EXPLANATION OF PLATE XLVII.

1. *Theristria eurysticta* Gerst Type-specimen.
2. *Campion rubellus* Navas
3. *Eucimacia nuchalis* Gerst Type-specimen.
4. *Mantispa pictiventris* Gerst Type-specimen
5. *Mantispa tenuistigma* Gerst Type-specimen
6. *Mantispa strigipes* Westw Type-specimen of *M pavidus* Gerst
7. *Austromantispa imbecilla* Gerst Type-specimen
8. *Austromantispa manca* Gerst Type-specimen

NOTES ON AUSTRALIAN DIPTERA WITH DESCRIPTIONS

By J R MALLOCH

(Communicated by E W Ferguson, M B, Ch M)

[Read 28th November, 1923]

Family MUSCARIDAE.

In this paper I give some notes on species which have usually been placed in the family Anthomyiidae. After a very careful investigation of a great mass of material from all parts of the world I have been forced to conclude that there is no line of demarcation between these so-called families, and consider that stressing a point or two merely to conserve the existing alignment in our catalogues is not the proper method of procedure to adopt. Stein in his most recent papers included the Muscidae as part of the family Anthomyiidae, but the former, being the oldest name for the complex, must be used in preference to the latter. All the genera which I deal with in this paper belong to the group which has the first posterior cell of the wing not or but little narrowed at apex, the fourth vein being but slightly or not at all curved forward apically and never angularly bent some distance from its apex.

Most of the species were submitted to me by Dr Eustace W Ferguson, to whom the types will be returned, but some are from a lot sent to Dr Aldrich of the United States National Museum by Dr J Illingworth, and are placed in the institution which received them.

Subfamily PHAONIINAE

MUSCINA STABULANS Fallen

A very widely distributed species, occurring in Europe and America. I have before me two males from Blackheath, and Blue Mountains, N.S.W.

The flies often occur indoors and around houses. I have reared the species from decaying mushrooms in North America.

ANACLYSTA Stein

This genus was erected by Stein in 1919. The name had been previously used by Brauer and von Bergenstamm, but their genus was based upon an undescribed species and their description was erroneous, so that he rightly refused to credit it to them. Stein himself included *flavescens* Stein, a species which does not belong to *Anaclysta* but to *Eulimnophora*. I now designate as genotype of *Anaclysta*, the species *multipunctata* Stein. The principal characters of *Anaclysta* are enumerated below.

Differs from *Lamphora* in the same manner as does *Eukmnophora* Mallech, the base of the third vein being bare and the prosternum lacking the lateral setulose hairs, while the basal abdominal sternite is partly hairy. From *Eukmnophora* it differs in the very striking forward curvature of the fourth vein at its apex, the curvature beginning at the middle of its apical section, and the presence of a very distinct bristle on the ventral surface of mid tibia beyond its middle.

I have before me two species, neither of which agrees with any of those described by Stein, all of which were from Africa, nor with *flea* Wiedemann, described from Tranquebar.

ANACLYSTA RUFICORNIS, n sp

♂, ♀—Head and thorax black, opaque, densely yellowish-gray pruinose, antennae and palpi rufous yellow, thorax with three very faint pale brown linear vittae, the median one most distinct, the ground colour yellowish-brown. Abdomen rufous yellow, sometimes coloured as thorax, tergites 2 and 3 each with a small fuscous spot on each side which are widely separated and about midway between base and apex, and a narrow elongate spot of similar colour on each side of median line on anterior margin, the narrow space between the latter whitish, more pronouncedly so in the male, fourth tergite with or almost without a pair of faint median spots. Legs black in male, the apices of femora and bases of tibiae rufous yellow, in female the mid and hind femora and tibiae are entirely rufous yellow. Wings clear. Calyptres and halteres yellowish.

♂—Eyes bare, very narrowly separated, interfrontalia not obliterated, antennae short, arista subnude. Thorax with 2+4 dorsocentrals, only the two posterior pairs long, three or four pairs of short acrostichals and some weak hairs in front of suture, sternopleurals weak, the lower posterior one sometimes absent. Abdomen ovate. Fore tibia unarmed at middle, mid tibia with one posterior bristle, hind femur with two or three bristles on basal half of posteroventral surface and a complete but sparse series of bristles on anteroventral surface which are shorter basally; hind tibia with one anterodorsal and one or two anteroventral bristles. Outer crossvein curved, at about its own length from apex of fifth, first posterior cell about one-third as wide at apex as at middle, where it is widest.

♀—Frons about one-third as wide as head, narrowed posteriorly, each orbit at base of antennae one-third the width of frons, narrowed above, triangle slender, extending to anterior margin of frons, the space between it and the orbits linear. In other respects as ♂.

Length, 5 mm

Type, male, allotype, and two female paratypes, Eidsvold, Queensland, January 21, reared from cowdung. Paratypes, two females, Townsville, Queensland, two females, Gordonvale, Queensland, one female, Benares, India, reared from cowdung, March, 1907 (Major Smith).

The type of *flea* Wiedemann has the legs yellow in the female.

ANACLYSTA OBLITERATA, n sp

♂—Differs from the preceding species in having the antennae and palpi black, the dorsum of thorax more brownish and with three broad brown vittae, the median one very short, not extending in front of suture nor to posterior margin, disc of scutellum dark brown, margins paler, abdomen yellowish-brown, with marks similar to the other but the submedian spots are small, punctiform, contiguous, and close to anterior margin of tergites; legs black, tibiae reddish basally.

Frons narrower than in preceding species, interfrontalia obliterated in centre. Thorax with three pairs of short presutural acrostichals; sternopleurals rather strong. Tibial armature as in last species but the hind femur has no basal posteroventral bristles, and those on anteroventral surface are confined to apical third. First posterior cell of wing fully half as wide at apex as at its widest part. Otherwise as *rufoformis*.

♀.—Similar to the male. Abdomen black, densely yellow-gray pruinose, the spots black and prominent, the submedian pair separated.

Length, 5 mm.

Type, Belaringar. March 20, 1915. Allotype, Eccleston, Allyn River, Feb. 26, 1921.

METOPOMYIA Malloch

This genus is similar to *Helina* R.-D., differing only in having the pteropleura with some hairs in centre. The under side of the scutellum is finely haired, prealar bristle present, first posterior cell widened apically, and arista short haired.

METOPOMYIA ATROPUNCTIPES Malloch

The only known species of the genus.

Fulvous yellow, palpi, antennae, apices of all femora and tibiae, bases of mid and hind tibiae, and all of tarsi black. Thorax slightly rufous vittate, and with a fuscous vitta from humeral angle to base of wings. Wings yellowish.

Thorax with four pairs of postsutural dorsocentral bristles, sternopleurals 1-2. Fore tibia unarmed at middle, mid tibia with two posterior median bristles, hind femur with a few sparse short black bristles on apical half of anteroventral surface, hind tibia with an anteroventral and two anterodorsal bristles, the posterodorsal setulae distinct on apical third or more. Outer cross-vein curved, at its own length from inner.

Length, 7-8 mm.

Loc.—Barrington Tops, December, 1921 (G. Goldfinch), Blue Mts., January, 1922, Fish River, March 25, 1923 (Health Dept.).

Originally described from Victoria.

HELINA FUSCOFLAVA Malloch

This species superficially resembles *Metopomyia atropunctipes* Malloch, but is a true *Helina*, with bare pteropleura and other characters similar to species of that genus.

The antennae are yellow at bases, palpi yellow, only mid and hind femora at apices and the tarsi black, pleura with or without a fuscous streak above, and thorax and abdomen more noticeably pruinose and marked. Chaetotaxy as in *atropunctipes*, but the hind tibia has one anteroventral and one anterodorsal bristle.

Length, 5.5-7 mm.

Loc.—Two males, both with a small label "Austr.", one having an additional label with "Sydney and Moreton Bay E. Daniel." Two males and one female, Sydney.

HELINA SIMULATA, n.sp.

♂.—Similar to *addita* Walker in colour, being black, with dense gray pruinose, the thorax distinctly quadrivittate, and the abdomen spotted; the legs are black, with rufous tibiae, and the cross-veins of the wings are distinctly infuscated. The abdominal markings are however less pronounced and there are additional checkerings not present in *addita*.

Eyes short haired, longest hairs on arista about as long as width of third antennal segment, thorax with three pairs of postsutural dorsocentral bristles, prealar small, sternopleurals 2 2, hypopleura bare, one or two pairs of long presutural acrostichals present. Fore tibia without median posterior bristle, hind femur with five or six long bristles on apical half of anteroventral surface, hind tibia with two anterodorsal, four or five anteroventral, and about seven short posterior bristles.

Length, 6.5 mm

Type, Ourimbah, N S W (Health Dept.)

This species runs down to Caption 10 first section in my key to Australian species of *Helina* recently published (Ann. Mag. Nat. Hist., v, 1922, p. 135), but differs from *victoria* Malloch in having the hairs of the arista longer, and the thorax with one or two pairs of presutural acrostichals.

RHYNCOMYDÆA Malloch

This genus differs from any allied one in having a vertical carina in middle of the face which separates the antennae.

There are two Australian species.

RHYNCOMYDÆA AUSTRALIS Malloch

A yellow species with frons in female, all tarsi, and sometimes part of the abdomen fuscous.

I have before me a female from Sydney.

RHYNCOMYDÆA CABINATA (Stein)

When I described the genus I was not certain that this species belonged to it, but I have now seen a series of specimens from Sydney and one or two other localities in New South Wales which prove that it belongs here.

It differs from *australis* in being black, with a bluish tinge, and in having the legs black, with the apices of femora and all of tibiae rufous.

Nothing is known of the larval habits of the species.

LISPOCEPHALA AUSTRALIS, n. sp.

♀—Black, densely yellowish-gray pruinose. Interfrontalia opaque black, triangle almost golden, antennae brownish-yellow, second segment gray above, arista dark brown, palpi yellow. Thorax with a narrow median brown vitta, and a faint brown mark behind suture laterad of the dorsocentral bristles, scutellum with the sides brown, pleura unspotted. Abdomen tawny, disc of tergites grayish, each with 3 large fuscous spots, a dark mark on each tergite below lateral curve. Legs tawny, coxae gray at bases. Wings hyaline, veins yellow. Calyptre and halteres pale yellow.

Frontal triangle extending to anterior margin of frons, each orbit with 4 bristles, the upper two directed backward, arista long plumose, longest hairs above at least as long as third antennal segment, parafacials and cheeks linear. Thorax as in the genotype, the scutellum longer, and the apical bristles curved. Legs as in genotype, mid tibia without an anterior bristle; basal posterodorsal bristle on hind tibia much longer than apical one, both anterodorsal bristles strong, one anteroventral bristle present. Inner crossvein just beyond middle of discal cell, penultimate section of fourth vein fully two-thirds as long as ultimate section.

Length, 4 mm

Type, Burnett River, Queensland (T. L. Bancroft)

This species differs from any species of the genus known to me in having the arista very long plumose. The hairs on arista in all other species are not as long as width of third antennal segment while in this species the longest are at least three times that length.

Subfamily FANNIINAE

This subfamily is distinguished from the others by the very short sixth wing-vein, round the apex of which the seventh forms a more or less distinct curve, though the vein itself is not distinctly evident. In the females there is one orbital bristle near the middle, which projects outward over the eye, and the upper one may also project outward, there are never more than three pairs of postsutural dorsocentral thoracic bristles, the hind coxae frequently have some setulose hairs on their upper posterior margin, and in the males the mid tibia is usually noticeably thickened from base to apex with, in some species, a rather abrupt demarcation between the basal third and apical two-thirds, while the ventral surface of the same tibia has dense pile or pubescence which is very noticeable in certain species. The abdomen in the males is usually flattened, while that of the female is normal.

All species known to me feed in the larval stages in fungi, manure, or decaying vegetable or animal matter. The common, cosmopolitan, indoor species *canicularis* Linné, is found in preserved meats at times, and some others have been found in the larval stages in the nests of bees and wasps. They are essentially scavengers and may at times cause intestinal myiasis because of their larval habits.

FANNIA CANICULARIS Linné

This species, which is about 4-5 mm. in length, has in the male usually the two basal abdominal tergites yellowish on the sides so that, when seen on windows, these segments appear semipellucid. The yellow colour is frequently absent in female but there are on the thorax three rather noticeable dark vittae which serve to distinguish the species from most of its allies. The hind coxa in both sexes has two setulose hairs at apex behind, and the hind tibia has the preapical posterodorsal bristle present.

I have seen several specimens from Sydney sent to me by Dr. Ferguson and also have seen it from New Zealand.

FANNIA AUSTRALIS, n. sp.

♂—Black, slightly shining, frons and face whitish pruinose, the frontal orbits palest. Thorax grayish pruinose, with four rather distinct black vittae. Abdomen bluish gray pruinose, with a narrow median black vitta and the anterior margins of tergites narrowly blackish, more broadly so in middle. Legs black. Wings grayish, veins black. Calyptres white. Knobs of halteres black.

Frons about one-eighth of head width, orbits linear, setulose on their entire length, interfrontalia wider than either orbit throughout its length, arista subnude; cheeks very narrow. Thorax not very hairy; presutural acrostachal hairs in three series. Abdomen normal; hypopygium not prominent. Fore tibia unarmed at middle; mid femur not noticeably attenuated apically, the anteroventral series of bristles short and not very stout basally, becoming shorter and closer apically, the posteroventral series longer and finer; pubescence of ventral surface of mid tibia microscopic, only one anterodorsal bristle present; mid tarsus longer than its tibia, unarmed at base; hind femur with one rather long and one or two

shorter preapical anteroventral bristles, posteroventral surface bare, hind coxa with about three short hairs above at apex. First posterior cell of wing narrowed at apex; penultimate section of fourth vein not longer than the outer crossvein and not over one-third as long as ultimate section. Lower calyptra much protruded beyond upper.

♀.—Frons normal, entirely opaque, sometimes reddish above antennae. Posterior margins of abdominal tergites not blackened, the tip of abdomen rather pointed. In other respects much as male.

Length, 3.3–5 mm.

Type, male, allotype, and three female paratypes, Sydney, N.S.W., October 29, 1922, one female, November 8, 1921, two females without data also from Sydney, one male and two females November, 1922; and one male and one female January, 1923, Sydney.

The black halteres, large lower calyptra, very simple armature of the legs, and the presence of setulae on hind coxae will serve to distinguish this species from any of the same size.

Subfamily LISPINAE

The members of this subfamily are distinguished from others by the presence of a group of hairs on middle of the pteropleura, the widely separated eyes in both sexes, dilated palpi, protruded lower calyptra, shortened sixth wing-vein, and usually some weak hairs, or at times rather pronounced bristles on the parafacials.

There are three genera found in Australia which may be separated as below.

Generic synopsis

- | | | |
|---|---|----------------------------|
| 1 | Cheek with one or two outstanding bristles near lower anterior angle of eye. | <i>Chaetohspa</i> Malloch. |
| | Cheek with only fine hairs, not bristled | .. 2 |
| 2 | Thorax with one pair of dorsocentral bristles situated in front of scutellum, fore femur with a few bristles on posteroventral surface apically, not with a complete series on that surface | <i>Xenohspa</i> Malloch. |
| | Thorax with at least two distinct pairs of prescutellar dorsocentral bristles, fore femur with usually a complete series of posteroventral bristles | <i>Lispa</i> Meigen. |

CHAETOLISPA Malloch

There is but one species of this genus known to me as recorded from Australia, *gemmata* Stein. It was originally recorded from Java and Australia and since then from Ceylon, India and China. So far I have seen no Australian specimens.

There are two other species with a strong genal bristle, *mochaeta* Speiser, and *dachaeta* Stein, both from Africa. They may belong to *Chaetohspa*.

LISPA Meigen

This genus is distributed over the whole of the world except in the extreme cold regions. The larvae are aquatic or semiaquatic, while the flies are found generally alongside of bodies of water, usually flying actively on the muddy margins.

Key to Australian species.

- | | | |
|---|--|------|
| 1 | Males | .. 2 |
| | Females | .. 3 |
| 2 | Hind metatarsus fully twice as wide as second segment, and but little longer | .. 3 |

than it, densely black haired below, frons, face, antennae, and palpi densely white pruinose, the palpi yellowish-white, legs black

- cana* Walker
- Hind metatarsus not noticeably wider than second segment and about twice as long as it, head parts not coloured as above, legs usually partly tawny, black in *armipes* 3
- 3 Fore femora with two or more series of very short and rather stout spines on the ventral surfaces besides the usual long posteroventral bristles; palpi and legs black *armipes* Becker.
- Fore femur with only the long posteroventral bristles, no short spines below 4
- 4 Palpi slightly and gradually dilated apically, thorax with 5 blackish vittae, the central one generally extending distinctly over scutellum, mid and hind femora each with some widely separated long bristles on anteroventral surfaces, first posterior cell of wing not appreciably narrowed apically *pumila* Wiedemann.
- Palpi with spatulate apices, thorax less distinctly vittate, the central vitta not continued over scutellum, first posterior cell of wing distinctly narrowed apically 5
5. Hind femur with some long setulose hairs at base on anteroventral and posteroventral surfaces, no strong bristles beyond middle on anteroventral surface *wescheri* Malloch
- Hind femur without long setulose hairs as above, but with one strong bristle beyond middle and another near apex on anteroventral surface *senochaeta*, n.sp
- 6 Thorax with one presutural and two postsutural pairs of dorsocentral bristles, all very long *unuseta* Malloch
- Thorax with two pairs of rather short presutural and usually two very short and two long pairs of postsutural dorsocentral bristles 6a
- 6a Fore femur with two or three series of very short stout spines on ventral surfaces in addition to the long posteroventral bristles *armipes* Becker
- Fore femora without such short spines, with only the long posteroventral bristles. 7
- 7 Legs entirely black, hind metatarsus thickened but not so much so as in male antennae short, gray pruinose, not over half the length of face, palpi dilated first posterior cell of wing not narrowed apically *cana* Walker
- Tibiae largely or entirely tawny yellow; hind metatarsus not dilated, antennae nearly as long as face, not gray pruinose 8
- 8 Median thoracic vitta usually distinctly visible over disc of scutellum, first posterior cell of wing not narrowed apically *pumila* Wiedemann
- Median thoracic vitta not carried over scutellum; first posterior cell of wing narrowed apically 9
- 9 Hind femur without strong anteroventral bristles beyond middle *wescheri* Malloch
- Hind femur with two strong bristles beyond middle *senochaeta*, n.sp.

LISPA CANA Walker.

A remarkably distinct species, easily recognisable by the white, almost silvery coating of the frons, face, antennae and palpi of the male. The thorax and legs are pale gray pruinose, the former vittate anteriorly, and the abdomen rather darker. Wings hyaline, veins fuscous, whitish basally. Calyptres white. Halteres brown.

Antennae about half as long as face; arista not longer than antenna, short haired; upper half of parafacials bare, lower half with very sparse hairs, palpi much dilated at apices. Thorax with 2+3 dorsocentral bristles; sternopleurals

1 2 Hypopygial claspers rather elongate, glossy along outer margins, tapered into a blunt chitinous process, with a shorter tooth on outer side near apex. Fore tibia with a fine median posterior bristle, mid femur much attenuated apically, mid tibia with a posterior median bristle, hind femur slender apically, with two median anteroventral bristles, and some setulose hairs on basal half of posteroventral surface, hind tibia without a pronounced median bristle, the anterodorsal hairs setulose, basal segment of hind tarsus a little longer than second and much dilated, with dense black hairs below. Veins 3 and 4 subparallel apically.

♀—Differs from the male in having the head yellowish pruinose, palpi yellow, hind tibia with an anterodorsal bristle, and basal segment of hind tarsus not pronouncedly swollen.

Loc—Sydney and Woolgoolga, N S W

LISPA PUMILA Wiedemann

Easily recognisable by the coloration of the thorax which has 5 fuscous vittae, the central one extending to apex of scutellum. The legs are black, with the bases of fore tibiae broadly yellow and all of mid and hind tibiae yellow. The palpi are but little dilated in either sex and sometimes slightly darkened. Dorsocentral bristles 2+4, the anterior two pairs behind the suture very short. Mid and hind femora of male with sparse long anteroventral and posteroventral bristles, usually paired, hind tibia of male with one anteroventral and one anterodorsal bristle, of female with an additional one on the posterodorsal surface.

Length, 4.5-5 mm

Stein described this species under the name *ignobilis* from Brisbane and Singapore. I have seen it from Queensland and Ceylon. I believe that *vittata* Stein is the same.

It bears a strong resemblance to the African species *leucospila* Wiedemann, but in the latter, the submedian thoracic vittae are very slender and usually broken, while in *pumila* they are nearly as wide as the central one and entire. The palpi in the African species are much more dilated at apices.

LISPA XENOCHAETA, n. sp.

♀—Belongs to the same group as *glabra* Wied., *assimilis* Wied., *modesta* Stein, and *wescheri* Mall. In common with these it has the thorax with 2+4 dorsocentrals, the anterior two postsutural pairs very short, and the fourth wing-vein distinctly bent forward on its apical section causing a slight but distinct narrowing of the first posterior cell. As in the others the palpi are yellowish and dilated, but the antennae are entirely black, without the rufous apex to second segment so pronounced in *wescheri*. The region laterad of and above the vibrissa, unlike that of *wescheri*, is almost bare, and the dorsum of thorax is very faintly vittate and entirely opaque yellowish-gray. The abdomen is similar to that of *wescheri*, having large blackish paired spots which connect in centre. Legs black, gray pruinose, extreme apices of femora and all of tibiae tawny, fore tibia with a median posterior bristle, mid tibia with one posterior and one ventral bristle beyond middle, hind femur with or without a short anteroventral bristle near middle and with one anteroventral and one posteroventral bristle at apex, both short, hind tibia with one anterodorsal, one anteroventral and one posterodorsal bristle. Otherwise as *wescheri*.

Length, 7 mm

Type, Pt Elliot, South Australia, January, 1922 (G. H. Dutton)

The outstanding character of the species is the ventral bristle on mid tibia.

LISPA WESCHEI Malloch.

For characters of this species see key and notes in description of last species.

Originally described from Port Melbourne. I have seen specimens from New South Wales, and Mt Eba, South Australia.

LISPA ARMIPES Becker.

A black, densely gray pruinose species, with almost entirely black legs, the thorax not vittate, abdomen with two pairs of black transverse subtriangular spots which are distinctly separated centrally, and the palpi fuscous, paler basally. The outstanding character of the species is the presence of dense short spines on the ventral surfaces of the fore femur in addition to the usual long posteroventral bristles. The first posterior cell of wings is not narrowed apically and there is no ventral bristle on mid tibia.

Length, 7-8 mm.

Occurs generally over Asia, I have specimens from Ceylon which do not differ in any respect from one female from Gerringong, N.S.W., and a male from Woolgoolga, N.S.W.

LISPA UNISETA Malloch.

This species is readily distinguished from its allies by the possession of only three pairs of dorsocentrals on thorax, all of which are strong. Only the female is known and I have not attempted to place the male in the key. I have placed the male of *monochaeta*, however, from characters of the female, but here care must be taken in identifying the species as I may have erred, the sexes of this genus being very often radically different in the armature of the legs and in other respects.

Originally described from Port Melbourne, Victoria.

XENOLISPA Malloch.

The species of this genus are more slender in habitus than those in *Lispa* and are not met with except in Africa and the Orient so far as I have seen.

Key to Australian species.

1. Wing with a prespical fuscous fascia beyond which the tip is white, fore coxae in both sexes yellow, hind femur of male without long bristles near base on ventral surface *albimaculata* Stein.
- Wing hyaline or yellowish, without prespical fuscous fascia or white tip . . . 2.
2. Tibiae and apical half of femora of mid and hind legs yellow, fore legs almost entirely black, the tarsi and tibiae of latter compressed, basal segment of hind tarsus of male curved and with rather dense black hairs which are longer than its diameter, basal segment of mid tarsus in same sex very slender and elongate, with outstanding setulose hairs below, which become denser and longer apically; tarsus of female normal, the fore pair much dilated or compressed *nigrimana*, n.sp.
- All tibiae and femora black, at most the former narrowly yellowish at bases 3.
3. Abdomen with a white spot on each side of tergites 2 to 4, trochanters black, hind femora of male with 6 or 7 long closely-placed black bristles which slope obliquely towards base of femur and are flexed at middle; thorax in both sexes distinctly vittate *sydneyensis* Schiner.
- Abdomen with a white spot on each side of third tergite, and in female a yellowish spot on each side of fourth; trochanters yellowish; hind femur of male with three long, fine, rather widely spaced bristles on basal third which curve towards apex of femur at their apices; thorax in neither sex with distinct vittae *albimacula*, n.sp.

XENOLISPA ALBIMACULATA Stein

This species is readily distinguished from its allies by the markings of the wings which are present in both sexes, the yellow fore coxae, and the lack of any outstanding bristling of tibiae in either sex. The third abdominal sternite in the male is produced in the form of a stout process in middle of hind margin, the process being furnished with microscopic black setulae at its tip.

I have seen a male and female from Tarro, Hunter River, N S W., October 18, 1922.

XENOLISPA SYDNEYENSIS Schiner

In the male sex this species is readily distinguished by the peculiar bristling of the hind femur as described in the key. The very distinctly vittate thoracic dorsum should readily separate the species in both sexes from *albimacula* which it most closely resembles.

Evidently the commonest species of the genus in Australia as I have seen it from Fish River and Sydney, N S W., and also from Burpengary, Queensland.

When I erected this genus I had but the female of the above species and did not recognise that it was the one described by Schiner, so inadvertently gave it a new name. This name, *atrifrontata* Malloch, becomes a synonym of *sydneyensis* Schiner.

XENOLISPA ALBIMACULA, n. sp.

♂ ♀—Shining black. Frons black, parafacials white pruinose, yellowish below, face brownish-yellow pruinose, cheeks and lower half of occiput whitish pruinose, antennae black, palpi yellow, whitish apically. Thoracic dorsum not noticeably vittate, pleura pale gray pruinose. Abdomen of both sexes with a large white spot on each side of third visible tergite anteriorly, of female with a less distinct central elongate mark in middle of hind margins of tergites 2 and 3 and a large faint grayish spot on each side of fourth visible tergite. Legs black, coxae gray pruinose, fore and mid trochanters yellowish. Wings slightly brownish. Calyptres whitish. Halteres obscure yellowish.

♂—Arista plumose basally, parafacial finely haired below, almost linear, palpi slender, with short moderately dilated apices. Thorax with one strong pair of prescutellar dorsocentrals, posterior upper sternopleural strong, the others minute, basal pair of scutellar bristles shorter than apical pair. Abdomen sub-cylindrical, third visible tergite longest on sides, fourth longest in centre, fifth sternite elongate, slightly asymmetrical, rounded apically, basal part of hypopygium (6th visible tergite) with a fringe of fine setulose hairs on its disc which are directed downward. Fore legs rather stout, mid femur swollen on basal half, slender on apical half, mid tibia very slender, with one posterior bristle; mid tarsus slender, basal segment with a few fine curved bristles at apex below; hind femur with three long fine downwardly directed bristles on basal half of anteroventral surface which are bent towards apices of femora at their tips, the rest of the femur with a fringe of short fine erect hairs; hind tibia stout and, like the two basal segments of hind tarsus, with some long setulose hairs ventrally. First posterior cell of wing hardly narrowed apically.

♀—Differs from the male in having the hind femur without conspicuous bristles or hairs; the mid tarsus normal, and the hind tibia with a better developed anterodorsal bristle near middle.

Length, 4-5 mm.

Type, male, allotype, 1 ♂ and 1 ♀ paratype, Babinda, North Queensland (Illingworth).

The male has the fore tarsus but little broadened, unlike that of *sydneyensis* in which the apical two segments are rather conspicuously wider than the others.

XENOLISPA NIGRIMANA, n.sp.

♂ ♀—Black, with a slight olive tinge. Frons brownish-black, opaque except on triangle, face yellow pollinose, occiput gray pruinose; antennae black, apex of second segment reddish; palpi yellow. Dorsum of thorax almost glossy, with faint pruinoscence, most distinct on two narrow vittae anteriorly in female, lateral margins of mesonotum and the pleura pale gray pruinose. Abdomen shining, with a pair of yellowish pruinose spots on posterior margin of first visible tergite, a central elongate spot of same colour in centre of next three tergites, a large posteriorly rounded white spot on each side of third tergite which does not extend to posterior margin, and the fifth tergite white, in the female the markings are similar but not so distinct. Legs black, trochanters, apical half of mid and hind femora and all of mid and hind tibiae tawny yellow. Wings clear. Calyptres white. Halteres yellow.

Frontal triangle narrow, extending to anterior margin of frons, ocellar and postvertical bristles weak, arista plumose, third antennal segment narrow, not extending to mouth, parafacial sparsely hairy, palpi moderately dilated. Thorax with one pair of prescutellar dorsocentrals; basal scutellars weaker than apical pair, upper posterior sternopleural strong, the others very weak. Abdomen narrow, fifth sternite entire in male. Fore tibia and tarsus compressed in both sexes, more so in female, tibia with a fringe of very short, closely placed, slightly flattened, black hairs dorsally and ventrally, mid and hind femora thick at bases and much thinner at apices, without abnormal armature in female, but in the male the hind femur has a fringe of short setulose hairs along the anteroventral and posteroventral surfaces, and about 4 long fine bristles on basal half of ventral surface; the mid and hind tibiae of female are normal, the hind one having a short median posterodorsal bristle, but the hind tibia in male is slightly curved, and has a series of long setulose hairs on basal half of posteroventral surface, and a similar series of shorter hairs on anteroventral surface, the apical one much the longest, hind metatarsus in male slightly hollowed out and with long black hairs on anterior side. First posterior cell of wing narrowed apically; inner crossvein slightly beyond middle of discal cell.

Length, 5-6 mm

Type, male, allotype, and 1 ♀ paratype, reared from pupae found in mud at edge of Burnett River, January 4, 1920. Paratypes, 1 ♀, Eidsvold, December, 1922, 1 ♀, Fish River, N.S.W., March 25, 1923.

The deep black dilated fore tibiae and tarsi readily distinguish this species.

Family DROSOPHILIDAE

The members of this family so far found in Australia are all small, none exceeding 4 millimeters in length and though some of them are cosmopolitan in distribution there are several now before me that appear to be undescribed.

The larvae of several species occur in decaying or injured fruits and in fermenting matter, and may cause myiasis unless care is taken to prevent them ovipositing on articles intended for food. Uncooked soft fruits which have been exposed for any length of time should be carefully examined to prevent larvae from being ingested when such foods are eaten uncooked.

In a subsequent paper I hope to be able to present a key to the families of

the Acalyptrata occurring in Australia but in this paper I include a key to the genera I have seen pertaining to the family Drosophilidae from Australia

The types of all new species will be returned to Dr E. W. Ferguson from whom I received the material

Key to genera

- 1 A distinct crossvein separating the discal and second basal cells of the wing, face without a well developed central vertical carina, costa to apex of fourth vein, without minute thorns at intervals on its penultimate section below, only one humeral bristle present *Amiota* Loew
No well developed crossvein between discal and second basal cells 2
- 2 Costal vein discontinued at apex of third vein or almost imperceptibly present beyond this point, the section between apices of second and third veins with a few microscopic thorns on its under side *Leucophenga* Mik
Costa continued distinctly to apex of fourth vein, without microscopic thorns below apically 3
- 3 Thoracic dorsum with at least six series of microscopic setulae in front of the space between the posterior dorsocentral bristles *Drosophila* Fallen.
Thoracic dorsum with two or four such series *Scaptomyza* Hardy.

N B—There are 25 valid known genera of the family

AMIOTA Loew

This genus is generally given the name *Phortioa* Schiner by authors, but the generic name *Amiota* has some months priority and must be used. Sturtevant made it a synonym of *Stegana* Meigen in his paper on North American Drosophilidae, but I have since pointed out that this is an error. The two genera are quite distinct and *Stegana* is more closely related to *Leucophenga* than it is to *Amiota*.

Nothing is known of the larval habits of the species of the genus. The adults are attracted to persons by perspiration and when they are common cause annoyance by getting into the eyes and ears.

There is but one species before me from Australia and, having failed to associate it with any already described, I consider it as a new species.

AMIOTA ANNULATA, n.sp

♂—Head ochreous, occiput with a large blackish mark on each side, gray pruinose along eyes, ocellar region and a spot on each side of vertex fuscous, frons whitish pruinose when seen from certain angles. Thorax darker than head, the disc of mesonotum and pleura largely fuscous, densely yellowish-gray pruinose, the dorsum with five interrupted dark brown vittae which resemble series of spots, one of these spots situated behind the prescutellar acrostichals and between them, scutellum mottled with brown. Each abdominal tergite with an elongated dark brown spot in middle forming an interrupted vitta, a large transverse spot of same colour on each side, almost connected with the median one, and a small spot on each lateral margin below, the ground colour ochreous. Legs ochreous, femora slightly browned, fore pair most distinctly so, each tibia with three brown annuli, a faint one at base, and two more distinct, one at middle and the other at apex. Wings hyaline. Halteres ochreous.

Eyes bare, anterior reclinata bristle nearly half as long as the proclinate orbital and midway between it and the posterior reclinata one; ocellars strong; postverticals weak. Prescutellar acrostichals distinct. Mid tibia slightly clubbed, and with about 4 erect hairs on the thickened apical part on anterior side, the longest one not as long as diameter of tibia. First posterior cell of wing nar-

rowed apically; outer crossvein at less than its own length from apex of fifth vein; penultimate section of fourth vein one-third as long as ultimate section

Length, 2.5 mm.

Type, Eidsvold

LEUCOPHENDA Mik

There are 45 recorded species of this genus. 19 of these are from Asia and the Orient, 11 from Africa and adjoining islands, 11 from the New World, 3 from Europe, and 1 from Queensland

So far as is known the larvae feed in fungi.

Key to species.

1. A conspicuous black mark on each side of scutellum at base, the thorax yellow 2
 Thorax, including the scutellum, unicolorous yellowish 3
2. Abdomen with three elongate black spots on each tergite including the first visible, the spots almost contiguous near hind margin, but not connected by a hind marginal band, the outer spot of the three on each tergite broadly connected with the one on the incurved part of same tergite
poschiventris, n sp.
- Abdomen with two widely separated black spots on dorsum of first visible tergite, a broad posterior band of black on each of the other tergites which is noticeably extended forward in middle and less so at sides, and a spot on lateral incurved margin of each tergite except first visible, which is not connected with the marginal band.
scutellata, n sp.
- 3 First visible tergite with about 4 long strong bristles along hind margin on each side of median line, the margin of segment snow white, as is the entire next tergite, base of third broadly silvery, the dark markings on dorsum consist of a pair of large transverse blackish spots on tergites 1, 3, 4, and 5, which are narrowly separated except on 5th, ventral portions of tergites on basal half of abdomen snow white, on apical half black and glossy
nivescens, n sp.
- First visible tergite yellow, with a black spot on each side on dorsum, second glossy black with a yellow spot on each lateral angle anteriorly, tergites 3 and 4 each black with a yellow spot on each side of median line anteriorly, lateral ventral portions of tergites black on their posterior margins
polita, n sp.

N.B.—A rather striking peculiarity of the four species is that in every case the halteres are yellow, with a black spot on the outer side of the knob. In the New World species the halteres are unicolorous yellow and only in two or three Javanese species described by de Meijere does this character occur again in the genus. One of the latter is very closely similar to *nivescens*, but I believe they are distinct, no mention of the very conspicuous bristles being made by de Meijere. I believe, however, that he has erroneously assigned another species from Java to this species, *albescens*, and that the one described in 1914 is distinct from the one he had in 1908.

One species described as a *Drosophila* from Australia by Bergroth is evidently a *Leucophenda*, but it is distinct from any before me. I give a copy of his description to facilitate its identification.

DROSOPHILA BELLULA Bergroth.

Fulva, dorso abdominis macula laterali segmenti primi, macula media subapicali segmenti secundi, macula laterali et media subapicali segmenti tertii et quarti (laterali segmenti quarti interdum deficiente), caepe etiam puncto media

segmenti quinti nigris ornato, ventre macula laterali segmenti tertii, quarti quintique nigris notato. Palpi longi et lati, compressi, apicem epistomatis sat longe superantes. Alae subhyalinae, ad apicem venae cubitalis brevissime apiculatae, costa solum ad apicem venae cubitalis pertracta, vena subcostali brevi, ante venam transversam anticam desinente, vena radiali apicem versus recta, longa ultra medium alae producta, vena cubitali apice a vena radiali quam a vena discoidali circiter duplo longius remota, segmento ultimo venae discoidalis penultimo paullo plus quam duplo longiore, vena transversa postica a vena transversa antica quam ab apice venae posticalis paulum longius distante. Pedes pallide testacei. Long 2.2-5 mm." Queensland

LEUCOPHENGIA FOECILIVENTRIS, n sp

♀—Head tawny yellow, ocellar spot fuscous, third antennal segment slightly brownish, upper half of occiput, except margin, black. Dorsum of thorax shining fulvous, pleura paler and thinly silvery pruinose, scutellum fulvous, paler along apical margin, and with a large black spot on each side at base. Abdomen as described in key. Legs stramineous, knees of mid and hind pairs a little darkened. Wings immaculate, all veins distinct. Halteres yellow, with a black spot on outside of knob.

Frons one-fourth of the head width, palpi slightly broadened, eyes bare, rays of arista 7-3. Prescutellar pair of acrostichals minute, not clearly differentiated. Bristles on hind margins of second and third visible tergites of moderate and regular length, rather widely and evenly spaced. Legs normal. Wing slightly pointed, third vein ending in tip, first posterior cell not narrowed apically, last section of fourth vein as distinct as others, about 2-2.5 times as long as preceding section, outer crossvein nearly erect and at about its own length from apex of fifth vein.

Length, 3 mm

Type, Blue Mts, January 26, 1922

LEUCOPHENGIA SCUTELLATA, n sp

♀—Differs from the preceding in being less shining, in having the apex of scutellum more noticeably yellowish-white, the black lateral spots on same smaller, and the abdomen marked as stated in key.

The head and thorax are as in last species, but the pair of prescutellar acrostichals are large and conspicuous. The mid tibiae in both species have the usual series of microscopic hairs on the posterodorsal surface. The wing is less pointed than in *foeciliventris*, the fourth vein has a very faint forward curvature at apex, and the penultimate section of fourth vein is half as long as ultimate.

Length, 3 mm

Type, Sydney. One paratype, bred from fungus, Sydney, May, 1915.

LEUCOPHENGIA NIVEIFASCIATA, n sp

♂ ♀—Head and thorax as in preceding species, but there are no black marks on the scutellum. The very conspicuous silvery white mark on abdomen which covers apex of first visible tergite, all of second, and the basal half of third tergites is the most characteristic feature of this species. In addition to this mark there are paired black spots as stated in the key, but the female has these less distinct basally and the apical two or three tergites are mostly blackish brown. Structurally as the preceding species, but the long bristles on first visible tergite, which are less conspicuous in the female, readily distinguish it from the others.

Prescutellar acrostichal bristles distinct Wings as in *scutellata* Palpi slender, with some fine black hairs

Length, 3-3.5 mm

Type, male, and 1 ♂ paratype, Woolgoolga, N S W., January 27, 1923

Allotype, Eidsvold, December, 1922 Paratype, ♂, Sydney, February 12, 1921.

LEUCOPHENGIA POLITA, n.sp

♀—Shining fulvous, the abdomen with black markings as noted in the key
As in the last species the legs are entirely stramineous

Palpi as in last species; frons nearly one-third of the head width Wing as in *scutellata*

Length, 3 mm

Type, Woolgoolga, N S W., January 27, 1923.

DROSOPHILA Fallen

This genus is the most generally distributed and the largest in point of number of species in the family. It is amongst the species of the *melanogaster* group that the species are found which have yielded such interesting results in laboratory work on evolution and heredity, etc. Most of them live but a short time in any stage, but they occur indoors at all times of the year. The larvae closely resemble those of the Ephydriidae, having two breathing tubes of variable length at the anal end; in the pupal stage, however, these tubes are retracted and sometimes the prothoracic pair are very much elongated. This reversal is due to the fact that in the larval stage the head is kept under the surface of the pabulum in feeding and the connection with the air is maintained by means of the anal tubes, while in the pupal stage the connection with the air is maintained by means of the anterior tubes which are correspondingly lengthened.

The key given here is not intended to give an idea of the number of species in Australia, which must be large, but to include only those which I have seen.

Key to species

1. Fore femur in both sexes with a comb-like series of minute black spinules on apical half of anteroventral surface, species almost entirely yellow, thorax with 8 or more series of minute setulae between dorsocentrals *immigrans* Sturtevant. 2
2. Fore femur without such a series of spinules in either sex 2
2. Thoracic dorsum with minute dark brown dots at bases of all the bristles and hairs, some of them aggregated on certain areas into larger spots 3
- Thoracic dorsum with 4 conspicuous broad dark brown vittae, the outer one on each side interrupted at suture, the submedian pair fused in front of scutellum, disc of scutellum of the same colour as vittae, the anterior lateral angles gray pruinose *lativittata*, n.sp
- Thoracic dorsum with 5 or 7 very slender dark brown vittae, pleura with two or three similar but broader vittae, disc of scutellum not much darker than basal lateral angles, third antennal segment fuscous, conspicuously darker than second *busckii* Coquillett
- Thoracic dorsum entirely without either distinct dots or vittae 5
3. Facial carina practically absent except between bases of antennae where it is sharp and linear, eyes bare *obsolata*, n.sp
- Facial carina conspicuous below where it is rather broad and vertically sulcate, eyes with stiff erect microscopic hairs 4
4. At least the first three tergites with a yellowish spot on the part that is incurved on venter *repleta* Wollaston

- None of the tergites with a yellowish spot as above *hydei* Sturtevant
5. Facial carina obsolete below, distinct and linear on upper part of face between bases of antennae, wings hyaline, outer crossvein slightly clouded, penultimate section of fourth vein half as long as ultimate *inornata*, n sp
- Facial carina conspicuous and broad on lower half of face . . . 6
- 6 Large species, at least 3 mm in length, wings evenly brownish, the outer crossvein narrowly but very noticeably clouded, easily seen with the unaided eye, last section of fourth vein 1.75 times as long as preceding section *brunneipennis*, n sp
- Smaller species, averaging under 2 mm in length, wings hyaline, outer crossvein not clouded, basal segment of fore tarsi in male with a comb of stiff contiguous bristles at apex on anterior side, last section of fourth vein over twice as long as preceding section . . . *melanogaster* Meigen
- N B—I include the description of *balteata* Bergroth, but suspect that it is a synonym of *melanogaster*. This cannot be decided without an examination of the type

DROSOPHILA OBSOLETA, n sp

♀—Head ochreous, brown on ocellar region, at base of anterior orbital bristle, and less so at bases of the other frontal bristles, third antennal segment blackish; palpi fuscous Thorax fuscous, densely yellowish-gray pruinose, a minute brown dot at base of each bristle and hair on disc of mesonotum, humeri and scutellum yellowish, the latter darker on disc Abdomen shining dark brown, hind margins of tergites yellowish Legs, including coxae, dirty straw-coloured, with a very slight indication of a darker annulus at base of each tibia Wings clear, crossveins almost unclouded Halteres yellow

Lower reclinate bristle small, close to base of proclinate, postvertical pair rather large, eyes without hairs, vibrissae well differentiated Thorax with 6 series of setulae between the dorsocentrals, sternopleurals 1 2. Legs normal. Sixth wing-vein subobsolete, penultimate section of fourth vein half as long as ultimate, outer crossvein at about its own length from apex of fifth

Length, 1.75 mm.

Type, Sydney, March 7, 1921 Paratype, Glenreagh, N S W., January 29, 1923

DROSOPHILA REPLETA Wollaston.

A larger species than the preceding, averaging about 3 mm in length, and more robust Usually there is a darkening of the apex of first wing-vein present which in some cases is quite conspicuous

There are three closely allied species recorded from North America, only two of which I have seen from Australia. Though the adults of these species are very similar, according to Sturtevant the immature stages are abundantly distinct

Loc --Sydney, Blue Mts, Lord Howe Island, and South Australia. Some of the specimens were taken in houses. The species is very common in lavatories in America

DROSOPHILA HYDEI Sturtevant

Distinguishable in the adult stage when pinned only as indicated in the key

Three specimens from Sydney.

DROSOPHILA BUSCKI Coquillett.

Another very widely distributed species which may be distinguished from its allies by the very narrow dorsal thoracic and broader pleural vittae.

Synonyms of this species are *rubrostriata* Becker and *plurilineata* Villeneuve. Recorded from North America, Western Australia, Canary Islands, Europe, and Africa.

Length, 2 mm.

One specimen, Sydney, January 8, 1921.

DROSOPHILA MELANOGASTER Meigen

Commonly listed as *ampelophila* Loew and known popularly as the Vinegar Fly.

There are one or two other species which have a comb at apex of basal segment of fore tarsus in the male, but none of these have been found amongst the material from Australia.

Loc.—Sydney, and South Australia.

DROSOPHILA IMMIGRANS Sturtevant.

Easily distinguished from its allies as stated in the key. The presence of a closely set series of minute black setulae on the apical third or more of the anteroventral surface of the fore femur is characteristic of many species of the family Lauxaniidae (Sapromyzidae) but the present species is a true *Drosophila*.

I have seen *immigrans* from Sydney and it occurs in Western Australia, North and South America, Europe, and the Hawaiian Islands.

DROSOPHILA INORNATA, n. sp.

♀—Ochreous yellow, slightly shining. Occiput and ocellar region infuscated, orbits gray pruinose, antennae and palpi ochreous. Dorsum of thorax slightly grayish pruinose and with very faintly indicated grayish vittae, postnotum brown, grayish pruinose. Abdominal tergites each with a dark area on each side which become larger posteriorly, the apical two tergites almost entirely brown or fuscous. Wings clear, outer crossvein slightly clouded. Halteres yellow.

Eyes sparsely haired; lower reclinate orbital bristle not half as long as proclinate one and close to base of latter; postvertical bristles long. Thorax with 8 intradorsocentral series of setulae, prescutellar acrostichals distinct; sternopleurals 1, 2, the upper posterior one large. Legs normal. Section of costa before apex of second vein four times as long as the one beyond it; outer crossvein at about its own length from apex of fifth vein.

Length, 2.5 mm.

Type, Blue Mts., January 15, 1922. Paratypes, two poorly preserved specimens, Sydney.

DROSOPHILA BRUNNEIPENNIS, n. sp.

♀—Dark fulvous, slightly shining. Head without distinct markings. Thoracic dorsum with faint indications of four darker fulvous vittae. Posterior third of each abdominal tergite fuscous. Legs fulvous yellow. Wings evenly browned, outer crossvein rather noticeably clouded with dark brown.

Eyes sparsely haired; frons a little over one-third of the head width; lower reclinate orbital bristle much less than half as long as proclinate one and a little closer to base of latter than to the upper reclinate one; rays of arista 4:2; facial carina almost equally wide on its lower two-thirds, flattened but not sulcate; vibrissae short and weak; palpi broadened. Eight series of intradorsocentral setulae; both the posterior sternopleural bristles long and strong; thoracic dorsum damaged by the pin so that it is impossible to say if the prescutellar acrostichals

are present. Legs normal. Outer crossvein at about its own length from apex of fifth vein, section of costa before apex of second vein three times as long as the one beyond it.

Length, 3.5 mm

Type, Sydney, September 24, 1922

DROSOPHILA LATIVITTATA, n. sp.

♂ ♀—Head fulvous, grayish on orbits, conspicuously so at bases of bristles, face whitish on sides, third antennal segment brownish above, palpi yellow; occiput blackened except on margins. Thoracic dorsum with 4 broad chocolate-brown vittae and the lateral margins of same colour, the narrow more or less broken interspaces gray pruinose, pleura dark brown, with some small gray areas. Each abdominal tergite with a broad transverse chocolate-brown mark on each side of median line on hind margin, which is dilated at inner and outer extremities on dorsum and more or less connected with a spot on lateral margins below, apical tergite in male yellow, in female dark brown. Legs tawny. Wings clear. Halteres yellow.

Eyes with dense stiff erect hairs, orbital bristles as in *brunneipennis*, facial carina with a short round flattened area below, vibrissae distinct. Thorax as in *brunneipennis*, the prescutellar pair of acrostichals distinct, the upper posterior sternopleural bristle long and strong. Section of costa before apex of second vein about 3 times as long as the one beyond it, outer crossvein at its own length from apex of fifth vein, last section of fourth vein about twice as long as preceding section.

Length, 2.2-5 mm

Type, female, and allotype, Sydney. One ♀ paratype, Sydney, Aug. 28, 1921.

DROSOPHILA BALTEATA Bergroth

"Testacea, limbo postico segmentorum dorsali abdominis nigro, segmentis tribus ultimis interdum totis nigris, quinto raro toto flavido. Alae subhyalinae, costa usque ad apicem venae discoidalis pertracta, vena subcostali brevi, ante venam transversam antecam desinente, vena radiali subrecta, sat longe ultra medium alae producta, vena cubitali apice a vena radiali quam a vena discoidali plus quam duplo longiore, vena transversa postica a vena transversa antica et ab apice venae posticae subaeque longe remota. Pedes testacei. Long. 1.8-2 mm." Queensland.

SCAPTOMYZA Hardy

All the species of this genus are distinguished from those of *Drosophila* by their more slender form and the presence of either two or four series of intra-dorsocentral setulae on the thorax. Otherwise the genera are very similar. The larvae sometimes mine in the leaves of cultivated vegetables.

Only one species from Australia is known to me. It rather closely resembles one described under the name *substrigata* by de Meijere from Java.

SCAPTOMYZA AUSTRALIS, n. sp.

♂ ♀—Head testaceous yellow, upper half of occiput black, ocellar triangle, vertex in centre, and orbits, whitish-gray pruinose, antennae and palpi yellow. Thorax black to yellow, in well preserved specimens densely gray pruinose and opaque, when rubbed showing glossy under the dusting. Abdomen brownish or yellowish basally, dark brown or black apically, with much less conspicuous dust-

ing than thorax. Legs including the coxae tawny yellow. Wings clear. Halteres yellow.

Eyes densely haired, facial carina complete, rays of arista 5 2. Thorax with 1 humeral, two series of intradorsocentral setulae, and sternopleurals 1 1. Abdomen and legs normal. Section of costa before apex of second vein about three times as long as the one beyond it, third vein with a very slight downward bend at apex so that the cell behind it is slightly narrowed at apex, the vein ending in wing tip, last section of fourth vein about 1.5 times as long as penultimate section, outer crossvein at a little over its own length from apex of fifth vein.

Length, 2.2-5 mm.

Type, female, and allotype, Sydney, the form with yellowish thorax. Paratypes, two from Sydney, also the yellow form, Nov. 12 and Dec. 6, 1920. Paratypes, mostly of the blackish form, Illawarra, N.S.W. (H. Petersen). This last lot sent me by Dr. C. F. Baker of the College of Agriculture, Philippine Islands.

Family CHLOROPIDAE

I have very little material in this family from Australia at present, but take the opportunity afforded in this paper to mention the existence of a new character for the recognition of the family and to redefine one of Becker's genera.

The character referred to above consists of a distinct flexure of the fifth vein directly below the inner crossvein. This peculiarity is emphasised in many cases by a slight elevation of the field of the discal cell which runs obliquely backward and upward to the fourth vein in front of the inner crossvein, and at this point the fourth vein is usually slightly weakened.

I have found this character of great value in determining the family relations of doubtful species such as belong to *Parahippelates*, and in only a very few cases of species which, in other respects, were without doubt true chloropids, have I found this flexure almost indistinguishable. No other family has this character, so far as I can discover, except some aberrant Ephydriidae.

PARAHIPPELATES Becker

This genus has been found only in New Guinea and Australia. It differs from nearly all other Chloropidae in having the orbits and interfrontalia with rather strong setulae, in possessing a pair of distinct cruciate postvertical bristles, moderately strong dorsocentral thoracic bristles, one incurved and one outcurved humeral bristle, at least one sternopleural, and two or more discal setulae on the scutellum besides the long marginal bristles. The curved bristle at apex on outer, or anterior, side of hind tibia, which it possesses in common with *Hippelates*, is sometimes very short. The genus belongs to the subfamily Oscininae, the costa being continued to apex of fourth vein and the hind tibiae having a flattened sensory area at middle on dorsum.

Nothing is known of the habits of the species, but in the adult stage *Hippelates* is very annoying to persons in North America by buzzing round the face in summer and getting into the eyes and nostrils, evidently attracted, like *Phortica* species, by the perspiration.

I have before me three species, none of which agrees with the description of *nudaeta* Becker, the only Australian species so far known.

Key to species

1. Wing with a large black patch in middle covering about one-third of its area, arista practically nude, not twice as long as third antennal segment, femora largely black *ornatipennis*, n. sp.

- Wings not so marked, either hyaline or faintly marked along the costa with pale brown, femora yellow 3
- 3 Dorsum of thorax fulvous yellow, very distinctly shining, with very faint pruinescence third antennal segment largely brown, arista with its longest hairs about as long as its basal diameter, costa of wing rather noticeably browned from apex of first vein to apex of fourth *brunneicosta*, n.sp.
- Dorsum of thorax gray-brown, but little shining, gray pruinescent, wings not marked as above 4
- 4 Arista densely short-haired, the longest hairs fully as long as its basal diameter *duplicata*, n.sp.
- Arista almost bare *wudiseta* Becker

PARAHIPPELATES ORNATIFENNIS, n.sp.

♀—Frons black above, yellowish in front, with dense pale gray pruinescence, yellow on anterior third and in front of ocelli, face yellow; occiput black; cheeks densely white pruinescent, antennae rufous yellow, with some white pruinescence; arista yellow, brown at base, palpi yellow. Dorsum of thorax shining chocolate-brown, with a broad yellowish-gray vitta between anterior dorsocentrals, which extends but little beyond the suture; scutellum coloured as mesonotum, with a large gray pruinose spot on each anterior lateral angle, pleura silvery gray pruinescent, except on extreme upper margin. Abdomen coloured as mesonotum, all of first visible tergite and the sides of the others silvery pruinescent. Legs fulvous, coxae, femora except apices, a median band on hind tibiae, and the apical two tarsal segments black. Wing veins yellow on basal half, fuscous beyond, a broad blackish band fills all the disc from a little beyond apex of first vein to apex of second, over the wing as far as fifth vein and to slightly beyond outer crossvein. Knob of halteres whitish.

Ocellar triangle indistinct, one pair of very noticeable interfrontal bristles, cheek about three-fourths of the eye height, the latter longer than high; vibrissal angle not much produced, the vibrissae small and weak, simple, antennae small. Thoracic dorsocentrals 1 + 3; anterior acrostichals indistinct. Legs more slender than usual, tibial spur very small and weak. Outer crossvein at not over its own length from apex of fifth vein and fully twice as far from inner crossvein.

Length, 3.5 mm

Type, Chelsea, Victoria, Sept 28, 1919 (F. E. Wilson).

PARAHIPPELATES BRUNNEICOSTA, n.sp.

♀—Head fulvous yellow, cheeks and face paler, with a whitish bloom; third antennal segment fuscous, yellow at base; palpi yellow; proboscis yellow, brown at apex. Thorax fulvous, almost glossy, with very faint yellowish-gray pruinescence. Abdomen concolorous with thorax, but crushed in type so that no markings show. Legs fulvous, apices of tarsi slightly darkened. Wings hyaline, with a faint brown shade along costal half from apex of first vein to apex of fourth. Halteres yellow.

Eyes subnude, frons half of the head width; triangle extending to beyond middle of frons; interfrontalia with black setulae, the median series long; third antennal segment not longer than wide; arista pubescent, about three times as long as third antennal segment; vibrissal angle distinctly produced, one moderately long and one short bristle present; cheek a little less than half of the eye height, the eye higher than long. Thorax with 1 + 3 dorsocentrals, acrostichals well developed, divergent posteriorly; scutellum flattened on disc. Spur of hind

tibia about as long as tibial diameter, strong Section of costa before apex of second vein fully 1.5 times as long as the section beyond it, veins 3 and 4 parallel, last section of 4 about 1.75 times as long as preceding section, outer crossvein at about 1.25 its own length from apex of fifth, the latter not reaching margin of wing.

Length, 4 mm.

Type, Darwin, Queensland (G F Hill).

PARAHIPPELATES DUPLICATA, n sp.

♂—Head testaceous yellow, with yellowish pruinescence; a large spot on each side of upper half of occiput, ocellar spot, arista, and apex of proboscis fuscous, frontal triangle more densely pruinose than remainder of frons Thorax broadly fuscous on middle of dorsum, margins of mesonotum and pleura rufous yellow, lower half of sternopleura black. Dorsum of abdomen coloured as disc of mesonotum, hind margins of tergites and the venter rufous yellow, hypopygium shining black Legs tawny, the apices of tarsi hardly darker Wings grayish hyaline, veins brown. Halteres pale brown.

Frons at vertex well over half as wide as head, narrowed anteriorly; interfrontalia with rather strong setulae, antennae small, third segment rounded, not longer than broad, arista with dense black hairs, the longest of which are fully as long as its basal diameter, eye elongate oval, longer than high, face almost vertical; cheek nearly two-thirds as high as eye, vibrissal angle with two short equal black bristles. Thorax as in preceding species. The glossy black hypopygium conspicuous, almost knob-like Spur on hind tibia distinct but not prominent Section of costa before apex of second vein about 1.25 times as long as the section beyond it; veins 3 and 4 subparallel; outer crossvein at fully twice its own length from apex of fifth, the last section of fifth about equal to penultimate section of fourth, the latter barely half as long as ultimate section of fourth

Length, 2.75 mm.

Type, Melville Is, N.T. (G F Hill).

PARAHIPPELATES NUDISETA Becker.

"Thorax und schildchen graubraun, kaum etwas glanzend, Acrostikalborsten in zwei Reihen divergierend; die Reihe der Dorsocentralborsten mit je vier längeren Borsten Schildchen und sternopleuren dem Gattungscharakter gemäss behaart oder beborstet; Brustseiten im übrigen ganz mattgrau.—Kopf gelb; Augen klein rund und nackt, Stern hinten doppelt so breit wie ein Auge mit einem ziemlich breiten, aber nur bis zur Stirnmitte reichenden rostgelben, etwas graubraun bestäubten Scheiteldreieck. Stirnfläche spärlich schwarz behaart, an den Augenrändern ungefähr je drei Orbitalborsten. Fühler rothgelb; drittes Glied fast rund klein, an der Spitze gebraunt mit einer längern fast nackten Borste. Mundborste vorhanden. Backen gelb, so breit wie 2/3 des vertikalen Augendurchmessers; Taster gelb; Russel rostbraun, glanzend mit etwas gekneuten schmalen Saugflächen. Hinterleib gelbgrau mit undeutlichen braunen Vorderrandbinden, deutlich und am Hypopygium ziemlich lang schwarz behaart. Schwinger weisslich. Beine rothgelb, Tarsenglieder kaum etwas verdunkelt; Hinterschienen mit deutlichem krummen schwarzen Dorn. Flügel deutlich etwas braun mit ganz derselben Aderung wie bei der vorigen Art. Länge des Körpers 3-3 1/2 mm." Sydney, Botany Bay.

Family AGROMYZIDAE

AGROMYZA ARTEMISIAE Kaltenbach

One female of this European species is before me from Botany Bay, N S W (H Petersen) It was submitted for identification by Dr C F Baker of the Philippine Agricultural College

Colour deep black, shining, the frons, face, and lateral margins of mesonotum lemon yellow Legs entirely black. Knobs of halteres yellow Outer crossvein very little beyond apex of first vein, last section of fifth vein twice as long as preceding section Thorax with two pairs of dorsocentral bristles

Length, 1 75-2 5 mm

The species has been found commonly in North America, where it has been known under the following names *platyptera* Thomson, *coronata* Loew, *jucunda* v d Wulp, *malvae* Burgess, and *lateralis* Williston It has been reared from larvae mining in goldenrod (*Solidago*), sunflower (*Helianthus*), aster, *Verbena*, and *Artemisia*

PHYTOMYZA ATRICORNIS Meigen

One female submitted along with the above and from the same locality

Evidently a cosmopolitan species, as it occurs in Europe, North America, Canary Islands, Formosa, and Australia, so far as known at present

Black, opaque gray pruinose, without vittae on thorax Head black, frons and face yellow, antennae and palpi black, the latter not dilated and the arista normal Thorax with four pairs of dorsocentral bristles and no seriate acrostichals Scutellum gray Abdomen without conspicuous yellow markings Legs including fore coxae black, apices of femora yellow Wings hyaline, first section about 1 3 as long as the next two combined, second less than half as long as third

Length, 1 5-2 mm

The larvae feed in many plants including the genera *Chrysanthemum*, *Helianthus*, *Erigeron*, *Senecio*, *Sonchus*, *Taraxacum*, *Lactuca*, *Centaurea*, *Scabiosa*, *Knautia*, *Isatis*, *Ononis*, *Phaseolus*, *Pisum*, *Brassica*, *Smagis*, *Cheiranthus*, *Lepidium*, *Galeopsis*, *Linaria*, *Phlox*, and *Papaver*

THE HIGH TEMPERATURE ORGANISM OF FERMENTING TAN-BARK

Part IV The effect of chill.

By R GREGG-SMITH, D Sc, Macleay Bacteriologist to the Society

[Read 28th November, 1923]

The fermentation of humate, etc, described in Part II, and of some carbohydrates had been tested by suspending or dissolving them in a solution of ammonium sulphate, magnesium sulphate, citrate of potash, and sodium phosphate and it was believed that the citrate was not fermented by the organism. The reasons for the belief were as follows —

1 A control test with 30 c.c. gave 2 mgrms of carbon dioxide on the second day and 1 more by the sixth when the experiment was stopped

2 Raw starch with 30 c.c. gave 3 mgrms on the first and 5 more by the seventh day

3. Hydrocellulose with 40 c.c. gave 10 mgrms by the fifth and 2 more by twelfth day

4 Charred cotton wool with 40 c.c. gave 13 mgrms by the seventh and 5 more by the fourteenth day

5. Inulin with 30 c.c. gave 9 mgrms by the second, 2 more by the fourth, 8 more by the eighth and 3 more by the ninth, a total of 22 mgrms in nine days

Allowing for some carbon dioxide contained in the original solution and adsorbed on the solids as in hydrocellulose and inulin, these quantities were within what was considered as being the error of the apparatus

It came therefore as a surprise after much work had been done with this supposedly inert medium to find that a control gave a considerable quantity of gas. The fermentation began on the sixth day

Carbon dioxide from 0.09 gram citrate in the medium

Days	3	7	8	9	10
Aggregate yield	8	20	41	55	68

From this it is clear that citrate is fermented by the bacillus and it is also clear that under some conditions it is not. Quite a number of experiments were made to determine what these conditions might be. Some of the experiments gave results that were not understood and which suggested further tests, but many led to nothing. Gradually, however, it was realised that possibly there might be a toxin associated with the bacteria. Experiments were made with cultures consisting chiefly of rods, with cultures consisting chiefly of spores, with steamed and with unsteamed cultures, but all gave indecisive results.

The toxin idea was tested by centrifugalising a suspension of cells and comparing the activity of the washed bacteria with the same volume of the original suspension. The race of the bacterium was one which had actively fermented

paper that had been tempered by *Asp fumigatus*. It seemed to be inactive towards citrate for a steamed culture, presumably consisting of spores, produced 11 mgrms of carbon dioxide in 20 days from citrate and an unsteamed control gave 8 mgrms. It was considered to be suitable for testing the point in question.

A seven days old culture of this race was used, half an agar slope being suspended in 5 c.c. of distilled water.

Table I Carbon dioxide in mgrms, aggregate amounts

Days		2	3	5	6	8
1	—0.3 c.c. of suspension centrifugallised	9	18	30	53	69
2	—0.3 c.c. of suspension	10	15	27	38	65
3	—1.0 c.c. of suspension			traces		

Centrifugallising the suspended cells and thereby removing the easily diffusible byproducts did to some extent accelerate the fermentation, for No. 1 fermented more rapidly than No. 2. The subsidiary test, No. 3, is rather interesting and it is difficult to understand why a heavier seeding should prohibit fermentation. The suspension was added to No. 3 half an hour after No. 2 and it may be that the longer action of the distilled water was responsible.

A second test was made with a two days' culture. The fermentation flasks were seeded half an hour after the preparation of the suspension.

Table II—Carbon dioxide in mgrms Aggregate amounts

Days		2	4	5
1	—0.4 c.c. of suspension, centrifugallised	17	50	60
2	—0.4 c.c. of suspension	13	39	37
3	—0.02 c.c. of suspension	9	20	23
4	—1.0 c.c. of suspension	—	3	3

The results confirm the previous experiment as regards the enhanced effect following the washing of the bacterial cells. It also confirms the inhibiting action of the larger seeding, viz., 1 c.c.

In the next experiment, one c.c. of a suspension was centrifugallised to see if the removal of the diffused bacterial byproducts would overcome the negative result which had hitherto followed the addition of this quantity of suspension to the nutrient citrate solution. A twenty hours' culture was first used and half an agar slope was distributed in 5 c.c. of water. The amounts of carbon dioxide that were evolved did not show the differences that had previously been obtained and the experiment was stopped on the second day. The remaining half of the slope, which had been kept at 60° for three days, was used for repeating the experiment. In the repetition, Nos. 3 and 4 were stopped on the fifth day to make room for other tests.

Table III—Carbon dioxide in mgrms Aggregate amounts

Age of seeding culture		1 day	2 days
Days		2	4
1	—1 c.c. of suspension centrifugallised	21	5
2	—1 c.c. of suspension	17	3
3	—0.02 c.c. of suspension	14	19
4	—0.2 c.c. of suspension	11	14

The older culture was much slower in starting and from the results of several experiments with 0.02 c.c. of suspension, it appeared that a one day's culture started to ferment during the first day, a two days old culture at the beginning of the second day and a three days old culture at the beginning of the third day.

The point about the experiment is that the elimination of the suspension fluid by centrifugalisation had little effect in removing any inhibiting substance. As living bacteria were in the fermentation flasks on the 8th and 11th days, it is difficult to understand why from three (Table i) to five (Table iii) times the number of cells, added to 30 c.c. of citrated nutritive fluid should result in an inhibition of the fermentation.

As it seemed possible that the simple sedimentation was not sufficient to eliminate all the inhibiting substance another experiment was made and in it the cells were sedimented, again suspended in water and centrifuged. It was considered that the double sedimentation might have a beneficial effect. An old culture (12 days) was taken to emphasise the point, but as the treatment did not induce the bacteria to ferment, the experiment was stopped on the ninth day. Even the fluid seeded with 0.02 c.c. did not ferment. A four days old culture was tested in the same way and with the same result. The experiment was stopped on the seventh day. A two days' culture was then tested with somewhat better results.

Table iv—Carbon dioxide in mgrms. Aggregate amounts

Days		2	3	4	5	7	9	10
1	—1 c.c. suspension, cells washed once	—	—	—	—	10	—	15
2	—1 c.c. suspension untreated	—	—	—	—	6	—	10
3	—0.02 c.c. suspension + unheated super natant fluid of 1	—	—	—	—	5	—	7
4	—0.02 c.c. suspension + heated super natant fluid of 1	—	—	—	—	3	—	6
5	—0.02 c.c. suspension, 90 minutes after preparation	—	—	18	20	35	61	66
6	—0.02 c.c. suspension upon preparation	19	30	36	45	61	73	78

The flasks were tested on the seventh day by abstracting small loops of the fluids and smearing them on saccharose media. Flasks 1, 5 and 6 showed a growth of bacteria, the others did not. Large loops on the ninth day showed that living bacteria were in all the flasks.

In No. 1, the bacteria were centrifuged and washed with 1 c.c. of sterile water and again centrifuged. Half a c.c. of the supernatant mother liquid was heated in boiling water for half an hour, cooled and to it was added 0.02 c.c. of the original suspension. After standing for half an hour the suspension thus treated was added to 30 c.c. of citrate solution contained in the fermentation flask (No. 4). No. 3 was a control to the last inasmuch as the half c.c. of supernatant mother liquid, derived from a duplicate sedimentation, was not heated. No. 5 was added to the fermentation flask at the same time as Nos. 3 and 4.

The experiment showed that if there was a substance capable of preventing fermentation and associated with the bacillus, the washing with water did not remove it. The addition of the supernatant mother liquid to 0.02 c.c. of suspension in Nos. 3 and 4 suggested that there was something of an inhibiting nature in the centrifuged liquid and that it was not affected by half an hour's exposure to 98°. There is also the suggestion in Nos. 5 and 6 that the time during which the water was in contact with the cells had an influence. The longer the contact, the slower was the fermentation in starting.

The replacement of the water by nutritive fluid less citrate was the next step and the saline suspension was added in increasing quantities. The results were erratic and as this could not have been brought about by the water as such, the idea was formed that the bacteria had really been influenced by the lowered temperature. They had been chilled by having been taken from the incubator at 60°

and distributed in water or saline at 24° (laboratory temperature at the time) and maintained at this for a variable period before being put into the 30 c.c. of cold nutritive fluid. Once the flasks were seeded they were generally put straight-way into the apparatus at 60°.

The idea was tested in set 2 in which the bacteria were suspended in saline and again in set 3 where water was used. In sets 2 and 3 the bacteria were kept at 60°.

Table v.—The Chilling of the Suspension

Suspension added to nutrient fluid at 24° or 60°	Set 1 24°			Set 2 60°		Set 3 60°		
Days Suspension	3	5	6	1	2	1	2	3
0 02 c c	—	—	—	—	10	—	—	32
0 05 c c	14	30	38	—	18	—	+	24
0 1 c c	—	—	—	+	34	+	+	27
0 2 c c	—	—	3	—	15	—	+	31
0 5 c c	28	50	52	—	19	—	+	28
1 0 c c	+	—	9	—	22	—	—	26
2 0 c c	—	—	—	—	15	—	—	14

The plus sign in the table means that the fermentation had begun either in the morning or in the afternoon of the first day, while the negative sign generally means no fermentation although sometimes it represents no determination, as in Table iv (9th day).

The comparison of sets 2 and 3 with set 1 shows a regularity in the fermentation when the bacteria were maintained at 60° by distributing them in fluid at that temperature and adding the suspension to the previously warmed nutritive fluid.

It is clear that much of what was previously considered to be a toxic or inhibitive effect was the result of this chilling of the cells. But there is probably something more than this, for the flasks of sets 2 and especially 3, seeded with 1 and 2 c.c. of suspension, show a retardation of the fermentation.

Thus there remains the probability of there being a toxin associated with the bacteria and it is possible that the chilling augmented the activity of this hypothetical substance.

The chilling effect was manifest when the cells were suspended in much water. On the comparatively dry surface of agar they are not so affected by cold. This was noted in the following in which the nutritive fluids in the flasks were seeded with bacteria taken directly from agar slopes. The infected cold flasks were allowed to stand for five minutes before they were connected up in the fermentation apparatus.

Table vi.—The Chilling of the Bacteria without previous Suspension in Water

Days	1	2	3	4
1 —24 hours' culture into cold fluid	10	19	25	32
2 —24 hours' culture into warm fluid	9	34	40	54
3 —48 hours' culture into cold fluid	7	17	26	33
4 —48 hours' culture into warm fluid	5	23	27	35
5 —As No 1 + 24 hours at 25°	10	18	28	36

The influence of the chilling is seen when Nos 1 and 2 are compared. The difference between Nos 3 and 4 is not so marked. It is possible that had the flasks been kept cold for a longer time than 5 minutes the differences might have been more pronounced. Some tests such as No. 5 were made with cultures that had been incubated at 60° and then allowed to stand at the laboratory temperature.

for a day or two. They fermented much the same as Nos 1 and 3 and indicated that chilling had little effect in the absence of a volume of water

It has been shown that large volumes of seeding suspension created an inhibiting condition and an experiment may be quoted in which the addition of large and small quantities of dry cells was tested.

Two cultures were used, one of a single day's, the other of a five days' growth. A small and a large amount of each were introduced directly into the nutritive fluids which were in all probability cold, for the experiment was made at a time when the influence of chilling had not been recognised. The small seeding was by means of a trace of bacterial growth at the tip of a platinum needle, the large seeding was half a small platinum loop.

Table vii—Small versus large Seedings without previous Suspension in Water

Days	2	3	4	6
1.—One day's culture, small seeding	1	19	27	42
2.—One day's culture, large seeding	4	5*	5	7
3.—Five days' culture, small seeding	6	12	21	36
4.—Five days' culture, large seeding	7	15	21	30

* A small loop of the fluid contained about 100 cells

The results showed that a small seeding of a one day's culture was far superior to a large seeding but that it did not matter how much of the older culture was used

In the early work, when it was believed that citrate was not fermentable, the culture fluids had been seeded cold with large loops of 20-hour agar cultures exactly the same as with No. 2 of the table and the same negative result always followed

A confirmation was made with the old and with a new race of the bacillus. A loop of fluid in contact with fermenting alley-bark had been spread on an agar slope the previous day and the growth that developed was used*. After seeding, the flasks were allowed to stand at the laboratory temperature before being connected up in the fermentation apparatus.

Table viii—Small versus large Seedings

Days	Age of culture	Race	Seeding	Set 1					Set 2				Set 3	
				1	2	3	4	6	2	3	4	7	3	5
1	—One day	new	small	—	—	—	14	—	—	—	12	55	—	—
2	—One day	new	large	—	—	—	—	4	—	—	—	8	—	—
3	—One day	old	small	6	+	17	31	—	15	22	—	—	12	29
4	—One day	old	large	—	—	—	—	2	15	31	—	—	—	—
5	—Two days	old	small	—	+	16	39	—	—	1	—	—	—	—
6	—Two days	old	large	—	+	33	42	—	23	27	—	—	—	—

The first set confirmed the previous finding as shown in Table vii. The second set also confirmed it as regards the new race but the old race gave irregular results. In the third set, the behaviour of the 20-hours' culture was similar to the first set.

* It is a comparatively easy matter to obtain a culture of the high temperature organism from alley-bark. A few grams of bark are heated in a flask at 150° for an hour. Upon cooling, 25 c.c. of a solution containing ammonium phosphate 0.4%, anhydrous magnesium sulphate 0.1% are added together with a gram of saccharose. After two days at 60°, a loop of the fluid smeared on a saccharose-agar slope should show many colonies of the bacterium.

A certain amount of irregularity is to be expected in biological experiments such as these and it becomes advisable to consider a number of experiments as a whole. When this is done with Tables vi, vii and viii we see that the inhibition of the fermentation of citrate was caused by at least three factors. The first was the use of large seedings of bacterial cells. The second was the chilling that the bacteria received when introduced into cold culture fluids and the third was the utilisation of races of bacteria more or less unaccustomed to citrate. There was no question of the action of water as such, for the bacteria were taken from agar slopes and distributed directly into the citrated nutritive fluids.

Cold by itself does not seem to have an injurious effect upon the bacterium, it is the combination of cold and mass of water. The bacteria that, as cultures on agar slopes were allowed to stand at laboratory temperature for one or two days, were as active at the end as at the beginning of the interval. This was shown in Table vi, No. 5 and with others unrecorded.

From a review of the work that has so far been done regarding the fermentation of citrate, it is clear that when a large number of cells are used, with or without a previous suspension in water and they are allowed to become chilled, there is a lowering of their vitality in some way so that they become unfitted to ferment citrate. Exactly how this occurs is not yet evident, although Table iv indicates that there may be formed some inhibiting substance which is not entirely removed by washing the bacterial cells. This suggests that the inhibiting substance either diffuses slowly from the cells or that it is slowly produced by the action of water from a parent substance.

While Table iv gives the suggestion of an inhibiting substance or toxin, the proof is given in the following. The bacteria on a four days' slope of saccharose-citrate agar were distributed in 10 c.c. of cold (22°) water and, an hour afterwards, the volume was made up to 150 c.c.

The suspension was filtered through a porcelain candle and the first runnings were as usual thrown away. Forty c.c. of the filtrate were shaken with 0.5 gram of fuller's earth which had been previously ignited, treated with hydrochloric acid and washed. After contact for twenty minutes, the suspension was filtered and refiltered through paper until a brilliant filtrate was obtained. Fifteen c.c. of this fuller's earth filtrate were put into a fermentation flask, 15 c.c. of the untreated porcelain filtrate went into a second flask and 15 c.c. of water was pipetted into a third flask. To each of these three flasks were added 15 c.c. of an ammonium sulphate-citrate solution of double strength. The flasks were warmed to 60° and a small seeding of a 20 hours' culture of the bacillus was introduced into each. The time occupied from start to seeding the flasks was two hours and ten minutes.

Table ix.—The Bacterial Filtrate. Four days' culture in water

Days	1	2	3	4	5	6	7	8
1.—Porcelain filtrate	—	—*	—	—	—	—*	—	8
2.—Porcelain filtrate treated with fuller's earth	4	16	+	56	64	+	+	67
3.—Water control	—	—	+	14	24	29	44	61

From the table it is seen that the porcelain filtrate contained an inhibiting substance as the water control began to ferment sooner. But on the other hand, the fuller's earth filtrate began before the control and appeared to contain an accelerating substance. Whence this came is a problem which future work must

* The porcelain filtrate (No. 1) on the second day contained 7 cells in 0.0155 c.c. and on the sixth day, 10 cells.

solve Did the colloid convert the inhibiting substance into an accelerating substance or did the porcelain filtrate contain a mixture of retarding and accelerating substances of which the colloid removed the first? Fuller's earth was employed because an investigation into the effect of colloids, such as kieselguhr and fuller's earth upon fermentation, was proceeding at the same time and fuller's earth had been found to give a stimulus to a slow fermentation

Before proceeding to draw conclusions regarding toxins, the experiment was repeated with variations Instead of a four days', a two days' culture was suspended in water The result appeared to show that it was too young, there did not seem to be enough inhibiting substance in the filtered suspension to show pronounced differences Then a three and a four days' culture were used During the tests, certain extensions were introduced to amplify the experiments The porcelain filtrate was boiled for an hour under an inverted condenser to note the effect of boiling It was also shaken up with alumina cream in the proportion of 40 c.c. of filtrate to 1 c.c. of cream The idea was to see if the electro-positive alumina behaved like fuller's earth

Table x—The Porcelain filtered bacterial Suspension

Set	1 Two										2 Three										3 Four										4 Four									
Age of culture in days																																								
Days of fermentation	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10
1—Porcelain filtrate, untreated	—	+	32	—	—	—	—	—	—	—	—	7	—	14	81	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
2—Porcelain filtrate, boiled	—	+	30	—	—	—	—	—	—	—	—	7	—	10	20	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
3—Porcelain filtrate shaken with fuller's earth	+	+	48	—	—	—	—	—	—	—	—	8	30	+	18	48	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
4—Porcelain filtrate shaken with alumina cream	+	+	40	—	—	—	—	—	—	—	—	6	25	+	20	42	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
5—Water control	—	+	29	—	—	—	—	—	—	—	—	—	7	+	23	46	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	

Set	5 Four										6 Four										7 Five										8 Five									
Age of culture in days																																								
Days of fermentation	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10
1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
4	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	

Notes on Table x—Sets 1 and 2 filtrate of race 7 (the stock race) seeded with the same race Set 3, filtrate of race 7 seeded with three drops (0.15 c.c.) of a warm (60°) suspension of same race Set 4 filtrate of race 7 seeded with one drop of a recently isolated race. Set 5 as set 4, on the third day a large loop (0.0115 c.c.) of the fluid of No. 1 contained 6 cells and on the sixth day 18 cells. Set 6 filtrate of new race seeded with the same race Set 7 filtrate of race 7 seeded with the same race. Set 8: filtrate of race 7 seeded with the new race.

The new race of set 4 had been isolated from alley-bark six weeks before the test was made and the new race of set 5 had been obtained from the same suspension of alley-bark four weeks later. The stock race 7 was the offspring of a colony from the non-fermenting fluid of Table viii, set 2, No. 5, which itself had been seeded with an old race. It had been transferred on saccharose citrate-agar daily for about a month.

In these tests, the most pronounced inhibitive action was obtained with sets 4 and 5. At one time it was considered that the rapid fermentation of sets 1 and 2 was caused by the cultures of two and of three days being too young and therefore containing an insufficiency of the inhibiting substance to retard the ferment-

tation to an extent which would show marked differences in the tests. It was considered that a four days' culture would show the differences more clearly. Set 3 did not bear this out and it was then believed that the reason lay in the seeding being too great. With a smaller seeding the results were better and sets 4 and 5 were considered to be very satisfactory. On continuing the work, however, it was found that there was something more than the seeding necessary to explain the sharper cut experimental work. Sets 6 and 7 fermented quickly and both had received a small seeding.

The results of sets 4 and 5 as compared with sets 6 and 7, showed that the most clearly cut differences in the individual tests were obtained when one race was used for preparing the filtrate and another was employed for the seeding. When this was done, the filtered suspension, as in sets 4 and 5, was pronouncedly inhibitive but when the same races were used both for the suspension and the seeding, the filtrate was not so clearly inhibitive. If the inhibiting substance should prove to be a toxin, it would seem that the race is not so sensitive to its own toxin as another race, it has become accustomed to it and is to a certain extent immune.

But the reason for the sharply cut differences between the individual tests lay in something deeper than the use of different races, for set 8 which was designed to prove the contention and which should have duplicated set 4, failed to do so, there was only a mild inhibitive action.

In sets 3, 6, 7 and 8, the amounts of carbon dioxide given off during fermentation show a comparatively similar speed of fermentation and the figures look as if we would be justified in endeavouring to strike an average in order to arrive at an approximate idea of the nature of the fermentation.

Table x, a.—Average of Sets 3, 6, 7 and 8 of Table x

Days	2	3
Porcelain filtrate, untreated	14	27
boiled	18	31
with fuller's earth	19	34
with alumina	21	36
Water control	20	36

The average shows in a clearer fashion what has been gathered, generally, from the examination of the results of the individual sets. The water in which the bacteria were suspended contained a substance which inhibited the growth and fermentative activity of the same bacterium and this substance was partly destroyed by boiling and by fuller's earth and completely removed by aluminium hydrate.

When set 8 showed a fermentation in all the tests at the end of the first day and when, in addition, some tests seeded with a large quantity of young cells, similar to Table vii, No 2, also fermented by the first day, it became evident that the bacterium had undergone some alteration. It was not so inhibitive as it used to be. Moreover the inhibition varied from time to time. In sets 4 to 8, all of which had been done in the month of May, there had been an evident alteration for sets 4 and 5 were different from sets 6, 7 and 8. The reason for this, after the behaviour of set 8, was not understood and in casting about for an explanation, some earlier notes upon the growth of the organism were remembered. It was recalled that the bacterium grew on saccharose citrate-agar, sometimes as an opaque and sometimes as a translucent colony. In the earlier work, the difference was explained by the presence of spores in the opaque colony and their absence in the translucent; the opacity seemed to be caused by the scattering

of light rather than by the presence of a pigment. Under the lens, the translucent colonies had a wavy margin, the opaque were white and with a margin like *B. subtilis*. The translucent colonies were spreading while the opaque were restricted. Microscopically, the opaque colony had a grey opaque centre with wavy wool-like tufts stretching towards the clear margin, the edge of which was undulate or erose. The translucent colonies were brownish, translucent and finely granular with an absence of the wool-like structure.

A fluid which had been seeded with the stock race was stroked on agar and about 5% of the colonies that developed were the translucent kind, the rest were the opaque type. When these were picked out and sown upon agar, the types remained fixed for at least a week during which some tests were made with them.

Films of the translucent or T type showed irregularly staining rods, debris (degenerate rods) and no spores. The opaque type, O, showed well-stained rods, many spores and little debris. It seemed as if the T race were very delicate and easily destroyed while the O race was of a hardier nature.

On saccharose citrate agar coloured with bromthymol blue, the T race in 1, 2 and 3 days showed an acidity of pH 6.4, 6.2 and 6.8 while the O race showed 6.6, 6.6 and 6.8. A recently isolated race, X, from alley-bark showed 6.8 during the three days. The translucent races therefore form more acid from saccharose than the opaque races.

Heavily seeded into 10 c.c. portions of ammonium-sulphate citrate fluid, in Freudreich flasks, the O race became turbid and deep blue, pH=7.4 or over. The T race remained at 7.0 for two days and then became 6.6. A large loop, holding 11 mgrms. of the latter was sterile on the second day. It was again heavily seeded and on the following day a large loop was found to contain six colonies or cells. It was again seeded strongly but did not become alkaline. There was a great reduction of the living cells for the flask was seeded with about half an agar slope five times in ten days and at the end of the period a large loop contained only ten living cells.

An experiment was made with a porcelain filtered suspension of a four days' culture of the T race but the filtrate did not inhibit the recently isolated race X. On the third day duplicates had yielded 45 and 48 mgrms. of carbon dioxide while water controls gave 38 and 40 mgrms.

As the filtrate of the T race was apparently incapable of inhibiting the opaque race, a trial was made with the O type. A four and a five days' culture were suspended in 300 c.c. of water and filtered. A portion was treated with alumina cream and filtered. After receiving an equal volume of double strength of ammonium sulphate-citrate fluid the warmed 30 c.c. portions were seeded with drops of warm suspensions of various races. These have already been alluded to with the exception of race 7 which was obtained on the previous day from an old culture of the date of Table x, set 4.

Table xi—Porcelain filtered suspension of Race O

Days		1	2	3	4	5	7
1.	Filtrate seeded with race O (opaque)	18	33	35	46		
2.	X (new)	16	23	37	52		
3.	T (translucent)	—	20	41	57		
4.	T (stock)	—	—	—	—	3	4
5.	Water control seeded with race O	16	30	43	54		
6.	T	—	—	—	—	10	50
7.	Filtrate + alumina seeded with race O	20	42	50	63		
8.	X	19	42	53	61		
9.	T	4	36	43	59		
10.	T	2	34	43	57		

The filtrate of the opaque race inhibited the translucent races but only slightly checked the opaque race for No 1 did not ferment so speedily as No. 5, the control. The opaque race, O, isolated from the stock culture appeared the same as the race, X, recently isolated from alley-bark and it may therefore be regarded as being the normal type. Race 7 was far more sensitive to the by-products of the opaque race than race T and yet these races had much in common. Both gave translucent colonies on saccharose citrate agar although it was considered that race 7 inclined more toward the normal type than race T. It was, however, rather difficult to classify them because much seemed to depend upon the moisture in the medium.

The water control, No 6, seeded with race 7 began to ferment between the 4th and 5th day while the filtrate, No 4, although containing living bacteria had not begun on the 7th day. During this time, the fluids in Nos 4 and 6 had been maintained in the neutral condition by the addition of drops of dilute ammonia. Once fermentation had begun, the fluids became alkaline and remained so.

From the fact that the filtered suspension of the translucent race did not inhibit the opaque race X, and that the filtered suspension of the opaque race did inhibit the translucent race T and especially 7, it is probable that the irregular fermentations recorded in Table XII were due to the employment of mixed types. The stock race 7 may at one time have consisted chiefly of the opaque and at another of the translucent races.

This is the more probable because although the types seem to be fairly stable when cultivated on agar they are not so stable in fluid culture. For example in the last experiment the opaque race became translucent in No 1 and a mixture of opaque and translucent races in No 2. The translucent race was stable in Nos 3 and 4 but became opaque in Nos 9 and 10.

In a further experiment in which the filtered suspensions of two opaque races were tested against the transparent races 7 and T, it was found that race 7 which was inhibited in Table XI was only retarded to a slight extent. Race T was more affected but there was no pronounced inhibition.

Table XII --Translucent races in filtered suspensions of opaque races

Days		1	2	3
Filtrate O seeded with race T	T	4	21	24
X	T	--	20	24
Water control	T	--	19	29
Filtrate O seeded with race 7	7	+	23	30
X	7	+	24	33
Water control	7	3	24	38

The curves of these numbers showed that the fermentations of the fluids containing the filtrates became depressed from the second to the third day, just as they did in Table XI, while the controls gave an almost straight fermentation. There was an inhibition of the translucent races by the water soluble products of the opaque races.

In another experiment, several sub-races of 7, when tested in the filtered suspension of the opaque race, all gave similar amounts of carbon dioxide and there was little evidence of an inhibiting action.

This failure to obtain a pronounced inhibitive effect led to testing the influence of having the suspension made in water at 25° because in the earlier work the air temperature was in this neighbourhood, whereas latterly the air temperature had been at 12°. Unfortunately for the idea, the aggregate yields of two

sub-races of 7 and of race T by the third day were all the same as the water controls. The filtered suspension of a four days' culture of the opaque race was absolutely indifferent.

A sub-race of race 7 was similarly tested with water at 25° and, like the last, it also did not inhibit the same sub-race or the opaque race.

A subsidiary test made at the same time confirmed the earlier work as regards the chilling of the cells. One c.c. of a suspension of sub-race 71 was added to 30 c.c. of culture fluid and the flask was allowed to stand at the laboratory temperature (14°) for an hour. After warming to 60°, a drop of a warm suspension of the same sub-race was added.

Table xiii.—The chilled Suspension

Days	2	3
1 —One c.c. of suspension chilled one hour	1	28
2 —The same seeded with a drop of warm 71	19	29
3 —Control seeded with warm 71	18	32

Nos 2 and 3 may be taken as being the same. It appears that although No 1 received 1 c.c., the chilling was responsible for reducing the numbers so that, by the time the flask was brought up to 60° in the fermentation apparatus, there were not as many active bacteria as were contained in a drop of which 22 went to the c.c.

The failure in these last experiments to obtain inhibitive effects such as were obtained for example in Table xi, leads to the conclusion that there occurs a variation in the nature of the bacterium. At one time, they give inhibitive products and at another they do not. Exactly when this may occur and why it should occur is no doubt interesting but it is rather beside the aim of the investigation which was to find out the cause of the non-fermentability of citrate.

The main reason for the non-fermentation of citrate was undoubtedly the chilling of the cells brought about by taking them from the incubator at 60° and suspending them in water at the laboratory temperature. Incidentally other subsidiary reasons were demonstrated. It was determined that the bacterium under artificial culture is prone to degenerate, changing from a type that grows as an opaque white colony on agar to others of a yellowish colour and more or less translucent. The opaque or normal type, for it is this type that emerges from the spores, has at times the power of giving up to water in which it may be suspended, a substance which has a more or less inhibiting action not so much upon the growth of its own kind as upon the translucent variety.

SUMMARY—The inability of the high temperature organism to ferment solutions of citrate was traced to the fact that the bacterium was sensitive to chill. Taken from the incubator at 60° and distributed in fluid at the laboratory temperature, it was so affected that while capable of existing or growing slightly, it was unable to ferment the organic salt. Large seedings of young cultures and large additions of suspended cells of older cultures, when chilled, failed to induce fermentation. Small seedings and additions were active.

There are two types of bacterium. The normal type, forming opaque colonies on agar, develops from the spore and becomes altered on cultivation to a less robust type forming translucent colonies. The normal type gives up to water a substance which inhibits the growth not so much of its own as of the derived type.

I am indebted to Mr. W. W. L'Estrange for much kindly assistance.

A CONTRIBUTION TO OUR KNOWLEDGE OF THE FUCACEAE

By MAY M. WILLIAMS, B.Sc.

(Twenty-three Text-figures)

(From the Botany Department of the University of Sydney)

[Read 28th November, 1923]

Investigations carried out by algologists during the present century have led to many interesting discoveries, especially among the Phaeophyceae. As a result of these investigations, we are now able to place a new interpretation on the group as a whole, and on the alternation of generations as it occurs amongst the various members. Consequently a new classification is becoming necessary. That given by Schaffner which has been, up to the present time, generally accepted, has been shown as a result of these investigations, to be quite erroneous. A classification given by Taylor, and published in December, 1922, takes into consideration all the more recent discoveries, and differs radically in many points from that given by Schaffner, more particularly in the fact that, in accordance with the more recent discoveries made by Williams in connection with *Laminaria*, the suborder has been removed from the Phaerosporales and placed amongst the Cyclosporaes, intermediate in position between Dictyotineae and Fucineae.

This classification proposed by Taylor also enables us to place a new interpretation on the Fucineae, and it is chiefly due to the investigations of Yamanouchi that this interpretation has been arrived at. The first cytological study of *Fucus* was that by Farmer and Williams (1896). The next year Strasburger's paper on "Kerntheilung und Befruchtung bei *Fucus*" appeared. In 1898 the final paper of Farmer and Williams was published. The work of Farmer and Williams and Strasburger deals only slightly with the first two mitoses of the oogonium, where it was inferred, but not actually observed, that reduction of chromosomes takes place. These works were followed by that of Yamanouchi (1909), whose paper consists of an account of an investigation into the cytological details of oogenesis and spermatogenesis, dealing more particularly with the details of the first two divisions of the oogonium and the antheridium. He states very clearly the points at which reduction division occurs.

However, most of these investigations have been carried out on various species of *Fucus*, *Hormosira*, *Cystosira*, and other genera of the Fucaceae, in other parts of the world, but there are many Fucoids in our own country which may confirm the results obtained by investigators elsewhere, and it was for this purpose that the present investigation was undertaken. The paper will deal with two of our well known Fucoids, namely *Notaria anomala* and *Phyllospora comosa*. Neither of these forms seems to have received a great deal of attention, so investigation in this direction seems desirable.

NOTHEIA ANOMALA

The most detailed account of this form so far published, is that by Harvey (1860). This plant is one of the parasitic Fucoids, in fact, to use Harvey's words "the only known Fucoid which is a true parasite." The plant is to be found growing on *Hormosira Banksii* in localities where that species occurs in the tide pools, it is therefore always covered by the water, even at low tide. In cases where *Hormosira* does not occur in such positions, and is consequently exposed at low tide, the parasite does not occur. Another peculiar feature is that periodically the parasite disappears from the particular tide pool or locality where it had been found previously.

The material from which the following investigations were made, was collected from Collaroy and Gerringong, N.S. Wales. The material collected from the latter locality showed the parasite growing out of the ostioles of the conceptacles of the host; that from Collaroy showed it opening out from the necks between the receptacles of the host as well. The material was collected at low tide and fixed in the field, the fixative used being a chromo-acetic solution, chromic acid 0.6 gms., glacial acetic acid 0.4 c.c., sea water 400 c.c., which proved satisfactory. After fixation the material was washed in sea water, dehydrated and passed in the usual way into paraffin. Sections were then cut with the microtome, varying in thickness from 3μ to 5μ and stained by one of the following staining processes—Fleming's triple stain, Heidenheim's Iron-Haematoxylin, or Magdala red and anilin blue. The first two of these gave the most satisfactory results.

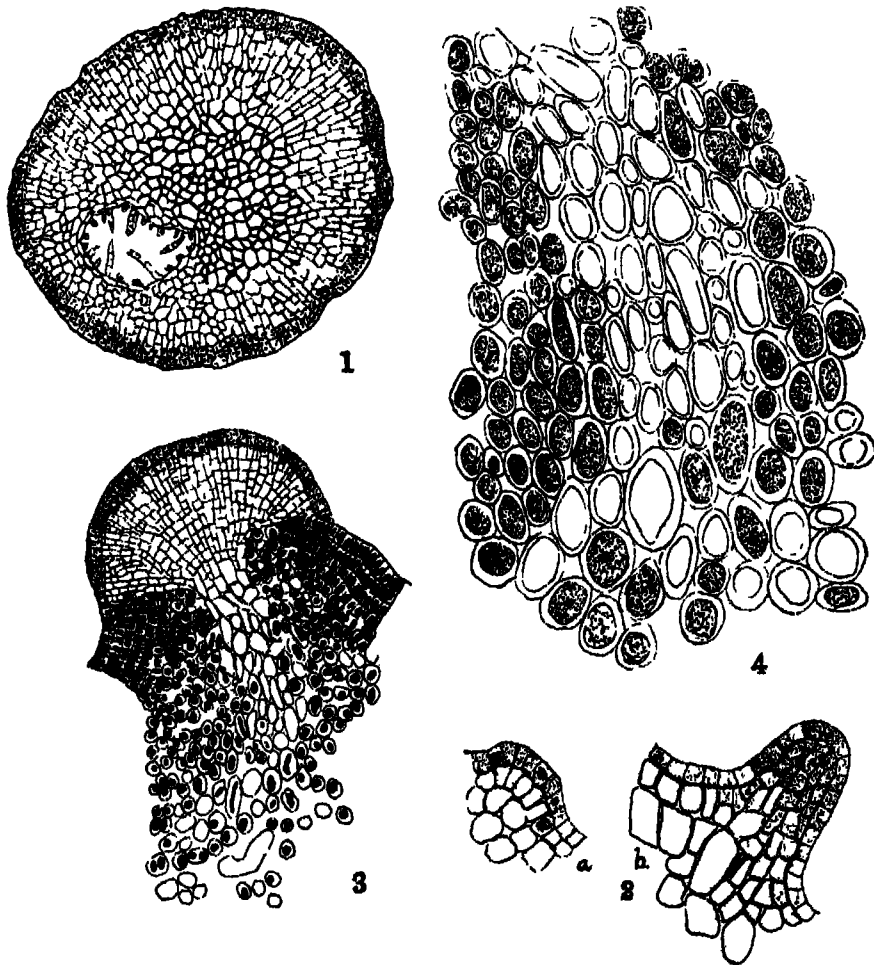
In this paper it is proposed to give an account of the chief results of an investigation made into the parasitism and oogenesis of *Notheia anomala*.

Notheia, as has already been stated, is a parasite growing on *Hormosira Banksii*, occurring on both antheridial and oogonial plants of that species, but it was found more frequently growing on the antheridial plant of the host. In all cases it showed very profuse branching, each branch springing from a conceptacle of some older branch. The conceptacles occur in great numbers, sometimes at the end of the branches, sometimes along the whole length, and contain only oogonia and unbranched paraphyses. Antheridia, antheridial conceptacles or antheridial plants have not been found so far, although a careful search has been made for them. The branches themselves are cylindrical in shape, much attenuated at the insertion, and tapering to a more or less acute apex. The colour of the plant is usually an olive brown.

In transverse section, the outline is circular, being broken only by the ostioles of the conceptacles. The tissue of the thallus, as in other Fucoids, is divided up into epidermal, cortical and medullary (Text-fig. 1). The epidermis is covered by a cuticle and contains the colouring pigments of the plant. A little of this also occurs in the upper cells of the cortical layer. The cortex gradually grades into the medulla, the cells of which show thickened mucilaginous walls.

Branching.—*Notheia* exhibits an altogether different type of branching from that found in the other Fucoids or even in the other members of the Phaeophyceae. In order to investigate this point, a series of sections was cut, longitudinal to the new branch, and transverse to the old one from which it arises. By this means it was seen that the new branch grows out of the conceptacle of the older branch. This seems to be due to the fact that some of the wall cells of the receptacle remain dormant during the formation of oogonia, and later, these cells divide and grow out to form a new branch, increasing in size and pushing its way out through the ostiole of the conceptacle (Text-fig. 2). Thus, when the new branch

is properly formed, there is seen in the section the old branch, the conceptacle of which contains paraphyses and oogonia and there is the appearance of the tissue of the thallus continuing to grow out into the conceptacle and through the ostioles.



- Text-fig 1 A section of a branch of *Nothsea* showing the vegetative tissue. A thick cuticle covers the epidermis, the cortex contains the colouring matter, and in the centre is the medulla, the cells showing thick walls. The conceptacle contains the oogonia (x 60).
- Text-fig 2 - A section showing a new branch arising. A is a young stage, the new branch just producing, B shows the new branch further developed (x 270).
- Text-fig 3 - A section of the point of penetration of *Nothsea* into its host. The absorbing organ consists of the colourless cells penetrating into the medulla of the host (x 60).
- Text-fig 4 - A section showing the relation of the parasite to the host. The large colourless cells are those of the parasite. (x 150).

Haustorial Organ—*Nothoia* has always been spoken of as a parasitic Fucoid, but no inquiry has been made into the organ, if such exists, which absorbs the food from the host. Investigation into this point is of extreme importance. As the plant contains some chlorophyll, one would be inclined to believe that it is not wholly parasitic.

Sections reveal that the attenuated end of *Nothoia* produces a kind of holdfast into the host. No definite haustoria, such as Fungi produce, penetrating the cells of the host could be seen. The organ which absorbs the food consists of a mass of loose elongated cells, arranged end to end, which penetrate the epidermis and cortex of the host and gradually merge into the medulla (Text-figs 3 and 4). These cells are absolutely colourless, and so stand out, in section, in strong contrast to the cells of the host which contain large quantities of colouring matter (Text-fig 4).

This haustorial organ seems to act as a kind of sucker, and probably absorbs the food by osmosis from the cells of the host. In several instances, sections revealed some of the cells of the host which contain chlorophyll being caught up by the tissue of the parasite (Text-fig 5). Whether this haustorial organ absorbs the raw food materials or the elaborated foods from the host is not known, but as the parasite contains some chlorophyll of its own, it would seem that it has the power of elaborating some of the raw food materials for itself, so it would seem quite possible that this is the main form in which the food is absorbed.

Another explanation given by Engler and Prantl (1897, p 280) is that *Nothoia* is not a parasite at all, but is merely an epiphyte growing on *Hormosira*. If this should be the case, the structure which is produced into the tissues of the host is merely a holdfast, so, given a suitable medium in the absence of *Hormosira*, the eggs should germinate and the plant develop. Experiments were made and failed, but this cannot be taken as final evidence, as the conditions of the experiment may have been unsuitable.

On the other hand, Harvey states directly that the plant is a true parasite, but he does not state by what means food is absorbed from the host.

It seems clear that here we have something more than an epiphytic habit, although it may have arisen from such. By the development of a small amount of tissue into that of the host the semi-parasitic habit may have arisen, the plant still retaining a certain amount of chlorophyll, and this in its turn has led to the true parasitic habit by the loss of chlorophyll and the development of still more tissue into that of the host. Taking into consideration in this case the fact that the parasite does contain a certain amount of chlorophyll of its own, it is probable that it is not dependent on the host for its entire food supply, but that it has the power of manufacturing a little for itself.

In all cases where the parasite attacks *Hormosira*, the cells of the medulla of the host are stimulated to divide and fill up the central vesicle. There is no need for any such vesicles to be supplied by the parasite, the buoyancy required being supplied by the host plant.

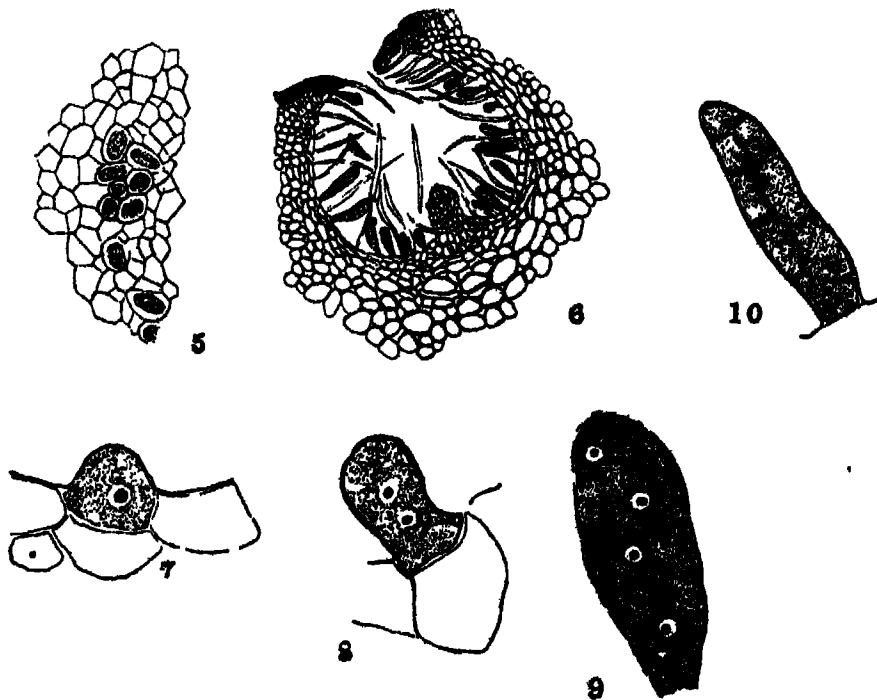
The presence of the tissue developed by *Nothoia* into *Hormosira* seems to prove that it is parasitic; and this too may perhaps explain the peculiar method of branching found in *Nothoia*, the new branch absorbing food from the older branch, in the same way as the parasite does from the host.

Conceptacles.—The conceptacles are monoecious, in fact, only one type of conceptacle, the oogonial, has so far been found to occur. It opens, as is found in all the Fucaceae, on to the surface of the plant by means of the ostiole, and

contains oogonia in all stages of development, unbranched paraphyses, and often a new branch is to be seen arising from the wall of the conceptacle (Text-fig. 6).

Oogenesis—Amongst the various genera of the Fucaceae oogenesis is of extreme importance since it differs so much in the various members of the Order *Nothia*, however, seems to conform generally with the condition found in *Fucus*.

The oogonia develop from the wall cells of the conceptacle. A wall cell puts forth a papilla (Text-fig 7), the nucleus of which divides so that there is produced a stalk cell and an oogonium proper. The stalk cell does not undergo any further development. The oogonium enlarges considerably in size and three



Text-fig 5 —A section showing the chlorophyll cells of the host incorporated in the parasite tissue (x 150)

Text-fig 6 —A section of a conceptacle. A new branch is arising, from the wall of the conceptacle the oogonia and paraphyses arise. (x 60).

Text-fig 7 —A section of young oogonium with one nucleus. (x 610).

Text-fig 8 —A section of an oogonium showing two nuclei (x 610).

Text-fig 9 —A section of an oogonium in the four nucleate stage. (x 610)

Text-fig 10 —A section of a mature oogonium showing the eight oospheres each with their cell wall and nucleus. (x 270)

mitoses occur within it (Text-figs 8 and 9) so that 8 nuclei are produced, each of which, with its attendant cytoplasm, becomes surrounded by a thin membrane and thus 8 eggs are produced (Text-fig 10). The cytoplasm of the oogonium is densely granular, the nuclei are large in comparison, with one large nucleolus and a thin nuclear membrane. The chromatin reticulum is extremely fine and in most cases cannot be seen at all (Text-figs 8, 9 and 10)

In this form, antheridia have never been found, so it would appear that, in their absence, the egg must develop parthenogenetically. The main cytological details of the oogonium were not worked out during this investigation, so whether reduction division occurs or whether the eggs are diploid cannot be stated at the present time. In the absence of antheridia it would seem that reduction does not occur and that the eggs are diploid. The absence of antheridia may be considered a primitive or reduced feature, and it seems to be probably a case of reduction here. This reduction in the complexity of sexual reproduction in accordance with specialisation in parasitism is not unknown amongst other members of the plant kingdom. Amongst the Fungi we find it occurring frequently, until finally, in some cases, all traces of sexual reproduction seem to be lost. In intermediate forms the eggs develop parthenogenetically, so that from this point of view, it may be said that here, as in some Fungi, the absence of antheridia may be taken as a reduced feature and not as a primitive one.

As a result of the recent works of Yamanouchi and Williams, the idea originally suggested by Strasburger seems to have become more definitely established, namely, that the oogonia and antheridia of the Fucaceae in their young stages should be regarded as sporangial in nature. Here, if the eggs do develop parthenogenetically, we have what may be considered as a reversion to this sporangiate condition in the oogonia, the egg developing in the same manner as the asexual spores.

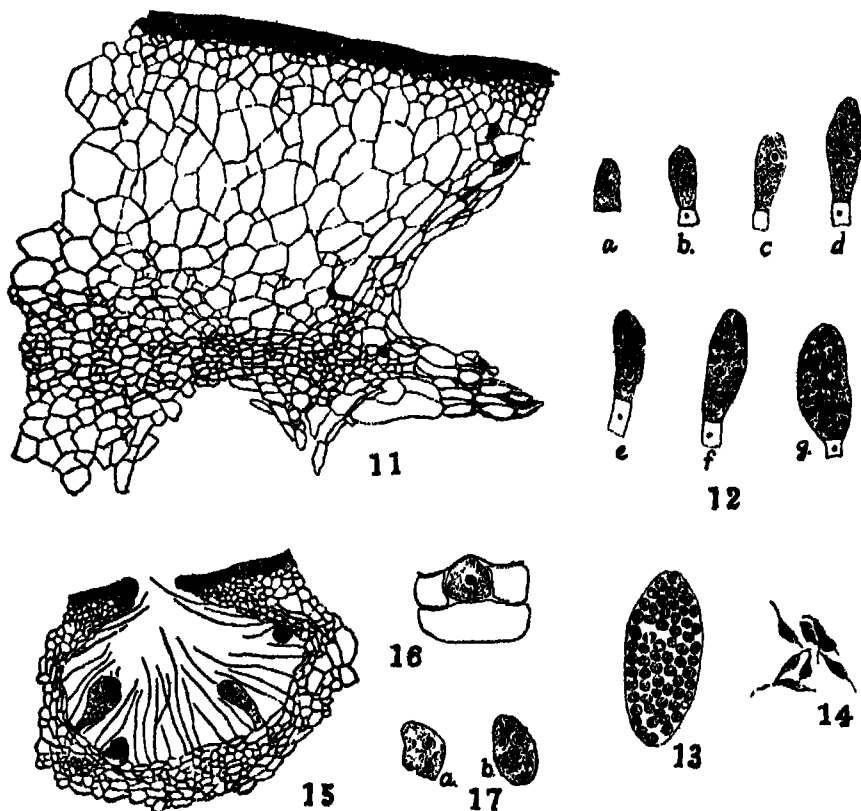
PHYLLOSPORA COMOSA.

This is one of our largest Australian Fucoids, the species itself being confined to the Southern Seas. It is a leathery type which grows in very exposed positions and is consequently very much battered about by the surf. The plant attaches itself to the rocks by means of a large root-like holdfast, from this a stout stalk arises which bears branches of a leafy nature. Some of these leaf-like structures bear conceptacles scattered over their surface, others do not. The branches also bear floats filled with various gases which maintain the buoyancy required by the plant. The plants are monoecious, the antheridial and oogonial conceptacles occurring on different plants. There is no noticeable difference in the colour of the two plants, but the oogonial appear to be more mucilaginous than the antheridial, also the ostioles of the oogonial conceptacles appear as brownish specks on the surface of the structures which bear them, and the conceptacles are not as long as in the case of the antheridial plants.

The material from which these investigations were made was collected from Collaroy, N.S.W. The same fixative, mode of fixation and washing, dehydration, etc., were used as in the case of *Nothoa*. The staining processes which proved most useful for this work were Flemming's Triple Stain and Heidenheim's Iron-Haematoxylin.

The vegetative tissue of this plant is much the same as in the other genera of the group. The transverse section is more or less rectangular in outline, the contour being broken here and there by the ostioles which lead down into the conceptacles. The tissue may be divided into three main parts, each gradually emerging into the other, namely, epidermal, cortical and medullary (Text-fig. 11). The epidermis is covered by a thick cuticle, and contains the colouring matter of the plant. The cortical cells are more or less irregular in shape, those near the epidermis being small and containing a little colouring matter; then they gradually increase in size towards the medulla, develop thicker walls and contain no colouring matter. The cells of the medulla form a kind of axial layer, the walls being extremely thick and mucilaginous.

The conceptacles bear either oogonia or antheridia. The antheridial conceptacles are very much longer than those containing the oogonia. The details of the antheridial conceptacles are very much the same as have been described by other investigators in *Fucus*.



Phyllospora comosa

- Text-fig 11 — A section of a branch showing the vegetative tissues. A thick cuticle covers the epidermis, the cortex, the cells of which contain the colouring pigments, the medulla, the cells of which have thickened walls (x 60)
- Text-fig 12 — A series of sections of the antheridia showing the development from the uni-nucleate condition to a stage showing 32 nuclei, in each case the stalk cell is shown (x 610)
- Text-fig 13 — A later stage in the development of the above showing 64 sperms. (x 610)
- Text-fig 14 — This represents the mature sperm after liberation from the antheridium. Each has 2 cilia, one nucleus and dense granular cytoplasm (x 610)
- Text-fig 15 — A section of an oogonial conceptacle showing the oogonia, paraphyses and the ostiole (x 33)
- Text-fig 16 — A representation of an oogonium in the uni-nucleate condition arising as a papilla from a wall cell of the conceptacle (x 270)
- Text-fig 17 — Two slightly older stages of the above (x 270) A the nucleus of the oogonia has divided and two nuclei are present. B these nuclei have undergone further division and 8 nuclei have resulted.

Spermatogenesis.—The antheridium arises as a small papilla from the wall cell of the conceptacle and contains one nucleus and a small amount of cytoplasm (Text-fig 12a). By division of this nucleus a stalk cell and an antheridium proper are formed (Text-fig. 12, b). The stalk cell may divide further and produce an antheridium directly or a papilla which, in its turn, may again give rise to an antheridium and its stalk, so there is thus produced a complex branching system bearing antheridia which, although they appear lateral in position, are really terminal. The young antheridium increases considerably in length, but not in breadth, and this growth of the cell is accompanied by a corresponding growth of its nucleus. The cytoplasm is very granular and deeply staining.

The nucleus of the young antheridium proper undergoes six mitoses (Text-figs 12, c-g), so that 64 nuclei are formed within it (Text-fig 13), each nucleus with its attendant cytoplasm separating out to form an antherozoid. After the third mitosis, as a result of which 8 nuclei are formed (Text-fig 12, e), the antheridium seems to undergo still further increase in length and breadth, so that by the time the sixth division has taken place the antheridium has attained its mature size.

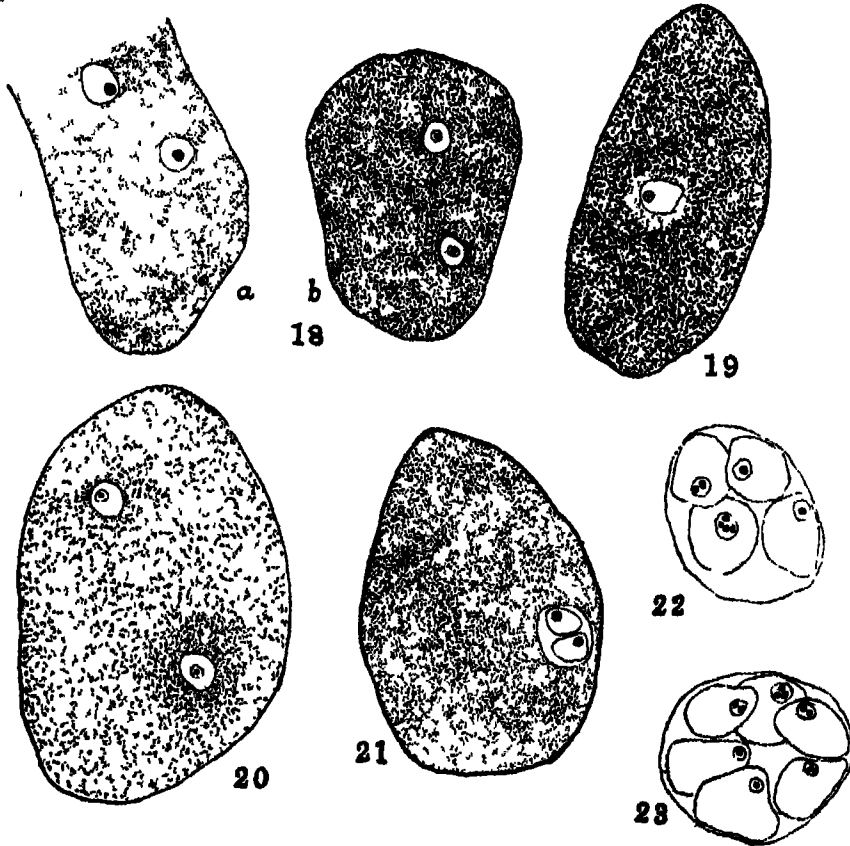
The spermatozoid is a long, narrow, more or less pear-shaped body, containing one nucleus, dense cytoplasm, and two cilia (Text-fig 14). The wall of the antheridium ruptures and the spermatozooids are discharged into the conceptacle, where they lie grouped together in a more or less mucilaginous mass, and are discharged from here through the ostiole into the water where they swim about freely.

It would appear, as has been described by Yamanouchi in *Fucus*, that division of the nuclei in the antheridium takes place at one time since all the nuclei were found to be in the one stage, the resting stage; mitotic figures of any kind were not observed at all. Also it would appear, from similarity in other details, that the reduction of the number of chromosomes takes place at the end of the second division of the antheridial initial.

Oogenesis.—Investigations carried out on the various genera of the Fucaceae, have shown that oogenesis varies considerably so that it becomes a matter of real interest in the group. It has been shown by the different investigators that, while some types conform with the condition found in *Fucus*, namely, that in which the oogonium produces eight functional oospheres, other genera depart from this; hence we get various modifications of this condition. For instance Getman (1914) has shown that in *Hormosira*, although 8 nuclei are formed, only four functional oospheres, each with one nucleus, are produced. In *Pelvetia* two functional oospheres are produced and in *Hymenothalia* only one.

The oogonial conceptacles of *Phyllospora* bear unbranched paraphyses and oogonia in all stages of development (Text-fig. 15), but the oogonia never show more than one oosphere. As in the other genera, the oogonia develop from the wall cells of the conceptacle. A wall cell puts forth a papilla (Text-fig. 16) which divides into two cells forming the oogonium and its stalk. The stalk cell does not divide further. The young oogonium contains one large nucleus and a small quantity of granular deeply staining cytoplasm. The nucleolus is extremely large and the chromatin threads very few, in fact, in most cases they cannot be observed at all. The oogonium increases only very slightly in size and three mitoses occur within it, thus producing eight nuclei (Text-fig. 17b). The nuclei at this stage are not very large, the nucleoli being almost as large as the nuclei themselves. The chromatin reticulum is extremely fine and in most cases cannot be seen at all. These mitoses must occur fairly rapidly, as there is hardly any

increase in the size of the oogonia while they are taking place. There is no trace whatever of any cell walls coming in, so there are eight free nuclei lying in a mass of coarsely granular cytoplasm. After this some of the nuclei begin to disintegrate and the oogonium begins to increase very rapidly and very considerably in size. Nuclei were actually observed in various stages of degeneration (Text-fig 18). Before the nuclei degenerate they seem to enlarge considerably. They



Text-fig 18 —Sections of an oogonium showing subsequent development. In A. there are two large and three small nuclei, the latter are undergoing rapid degeneration. B shows only one nucleus in that condition.

Text-fig 19 —A section of a mature oosphere at the time of liberation. An outer membrane surrounds thick granular cytoplasm and one nucleus. Surrounding the nucleus is a more finely granular protoplasmic zone. The nucleus shows a distinct nucleolus containing structures within it (x 270).

Text-fig 20 —The same as the above. In this case the oosphere has two nuclei. (x 270).

Text-fig 21 —A section of an oosphere which has been liberated from the conceptacle. This also contains two nuclei, but in this case they are surrounded by a common membrane (x 270).

Text-fig 22 —This represents four nuclei surrounded by a common membrane. (x 610).

Text-fig. 23 —The same as the above, but here six nuclei are represented (x 610).

do not necessarily degenerate singly (Text-fig 18b) or in pairs. In Text-fig 18a there are three nuclei undergoing degeneration. This process continues until finally there is only one nucleus left in this mass of cytoplasm (Text-fig 19). Observations failed to reveal which nucleus was ultimately selected or what factors influenced the selection of the functional nucleus.

The nucleus of the oosphere is extremely large, with one large nucleolus, a fine chromatin reticulum which is fairly evenly distributed and a thin nuclear membrane. The cytoplasm is also surrounded by a thin membrane, is very coarsely granular and contains various quantities of colouring matter. Surrounding the nucleus of the oosphere, however, there is a narrow zone of finely granular cytoplasm (Text-fig 19).

The nucleoli occurring in the nuclei of the oogonia of this plant in all cases are extremely large and exhibit in practically every case other structures occurring within them (Text-figs 19, 22, 23). These structures in the nucleoli are evidently not uncommon and have been mentioned by other investigators in other parts of the plant kingdom. For instance Wilson (1909), when making an investigation into "The spore formation and nuclear division of *Mnium hornum*" noticed that these structures occurred. He states that "Fischer has emphasised the fact that acetic alcohol (used in the fixative) causes the precipitation of some of the protoids in a soluble form, and it is possible that the appearance is due to partial solution of the nucleolus at the time of fixing and during subsequent treatment" (p. 144).

Wolfe (1904) also noticed such a condition when carrying out some cytological studies in *Nemalion*, and he remarked that the nuclei are not homogeneous in structure, so that certain parts of them show a more marked capacity for absorbing stains than others.

The oosphere increases considerably in size, even after this uni-nucleate condition has been obtained, in fact it becomes so large that on delimitation from the conceptacle, it can be seen with the naked eye, appearing as a dark brown speck. Numerous oospheres seem to be liberated in a common mucilaginous mass, becoming freed in the sea water. The oospheres vary considerably in size. Sometimes they are enormously large, in other cases smaller, but they are never very small. Before liberated the oospheres have two walls, a mucilaginous outer one and a thin inner one. When completely developed it escapes from the outer wall into the conceptacle and from thence through the ostiole into the sea water.

It was observed, as an occasional circumstance, that sometimes the oospores possessed two or three nuclei lying free in the general cytoplasmic mass (Text-fig. 20), there being no trace whatsoever of any cell wall separating them. Such a condition was also noticed by Farmer and Williams (1896, p. 481) in the oospheres of *Fucus vesiculosus* and *F. platycarpus*. The condition was also observed by Oltmann.

From this it is evident that *Phyllospora* has a type of oogenesis similar to that of *Pelvetia* in that only one egg is produced. This is not to be interpreted as a primitive feature in these types, as it is more certainly a case of reduction. Eight nuclei are formed first of all, and the uni-nucleate condition is attained by the breaking down of the supernumerary nuclei.

Getman (1914, p. 270) maintains that "while the details of oogenesis remain to be investigated in several of the genera of the Fucaceae, it seems certain that the eight nuclei condition is primitive and that most of the genera that contain less than eight eggs pass through this stage. A study of *Hormosira* shows that not only are eight nuclei formed, but eight eggs begin to develop, so that the

final four nucleate condition is reached by the breaking down of four immature eggs rather than four nuclei."

Farmer and Williams (1896, p. 481) also state that "Oltmann asserts that in *Ascophyllum*, in which only four oospheres are commonly formed, eight free nuclei occur at an earlier stage, but four of these abort and do not become centres of cell formation. Our observations tend to confirm him in this respect but we found that in some cases, a fifth oosphere, smaller than the rest, was occasionally differentiated, and when freed from the oogonia it exerted an attraction on the antherozoids just like its sister oospheres."

Phyllospora agrees with the general assertion, namely, that in the Fucaceae where less than eight oospheres are produced within the oogonium, eight free nuclei occur at an earlier stage. Observation showed that cell walls were absent during all stages of development, so it cannot be claimed here as Getman has done in the case of *Hormosira*, that the final uni-nucleate condition is obtained in the breaking down of immature eggs rather than nuclei.

Although we have, in this case, a reduction in the number of oospheres produced, this is counterbalanced by their enormous size, hence it will exert a greater chemotactic influence over the spermatozooids, so that fertilisation is thus insured. Also on account of its size it will have a larger quantity of reserve food stored within it, so that development after fertilisation is certain to take place. Such instances of reduction in number and increase in size of the oosphere are not uncommon amongst the other members of the plant kingdom.

A condition of some interest observed during these investigations was one in which the oospheres which had been liberated from the conceptacle surrounded themselves by thick mucilaginous walls and the nuclei divided until as many as six nuclei occur in the oosphere, in close association surrounded by a common membrane (Text-figs 21, 22, 23). It would seem that as fertilisation had not taken place, the oosphere had commenced to develop parthenogenetically. In addition, in many cases, there was often one large nucleus in the centre of the oosphere. How the common membrane surrounding the nuclei originated, and what are its uses, cannot be stated.

For a long time it has been considered that the Fucaceae were out of harmony with theories formed on alternation of generations, but in accordance with the recent discoveries made by Williams (1921) in *Laminaria*, we are now able to place a new interpretation on them. Yamanouchi (1909, p. 189) asserted that as a result of his investigations, the idea originally suggested by Strasburger that "the oogonia and antheridia in their young stages should be regarded as corresponding, not with the oogonia and antheridia of *Dictyota* but with its tetrasporangia" was confirmed. He further adds (p. 190) that in *Fucus* the antheridial and oogonial initials up to the second division may well be compared with the spore mother cells in higher plants, and that the four nuclei in these structures thus produced may be compared with microspores and megaspores, which in *Fucus* germinate at once within the oogonium and antheridium, and the gametophyte generation thus initiated undergoes only one mitosis in the oogonium and four in the antheridium.

Speaking of the conclusions derived from his work on *Laminaria* Williams (1921) states: "A study of the cytology of the different phases confirms the conclusion arrived at on morphological grounds that in the Laminariaceae we have pronounced alternation of generations with a great reduction of the gametophyte. The cases in Laminariaceae where the gametophyte consists of a single cell, separated from the zoospore by a single nuclear division, make it easy to adopt

the suggestion that the so called oogonia and antheridia of *Fucus* are sporangia" (p 607).

Taylor (1922) has taken into consideration all these recent discoveries, and has made several alterations in the classification given by Schaffner and is thus able to give more feasible explanations of phenomena occurring within these groups. The main divergence from the classification given by Schaffner is that the sub-order Laminariaceae has been removed from the Phaeosporales and placed among the Cyclosporaes, intermediate in position between the Dictyotaceae and the Fucaceae. He asserts that in the Dictyotaceae we have morphological alternation of similar generations. In the Laminariaceae we have morphological alternation of dissimilar generations, the gametophyte being much smaller than the sporophyte. In the Fucaceae there is only cytological alternation of generations present. Members of the Fucaceae form their spores in pits or conceptacles. Still enclosed, the spores undergo a few cell divisions, or even only a few nuclear divisions, forming the gametes which are shed as eggs and sperm. This is the climax family of the Brown Algae and represents the greatest reduction of the gametophyte possible while still retaining an alternation.

The cytological details of *Nothoa* and *Phyllospora* will be published at some later date.

Summary

A. *Nothoa anomala*.

1. The vegetative tissue is divided into three parts, namely, epidermis, cortex, and medulla.
2. New branches are produced by the older branches and grow out through the conceptacles of the latter.
3. There is an haustorial organ produced which penetrates the tissue of the host, and absorbs some food for the plant.
4. The conceptacles are monoecious.
5. Only oogonia have been found to exist up to the present time, antheridia do not occur.
6. Eight functional eggs are produced in each oogonium.

B. *Phyllospora comosa*.

1. The vegetative tissue is divided into the epidermis, cortex and medulla.
2. The plants are monoecious.
3. Nuclear division in the antheridium results in the formation of 64 sperms.
4. Each sperm possesses granular cytoplasm, one nucleus, and two cilia.
5. One functional oosphere is produced by each oogonium. This condition develops from the earlier state, in which eight nuclei occur, by the disintegration of the supernumerary nuclei.
6. Each oosphere contains granular cytoplasm and one nucleus; in some instances, however, two nuclei may occur.
7. In several instances sections revealed oospheres containing from two to six nuclei surrounded by a common membrane.

In conclusion I wish to express my sincere thanks to Professor Lawson and Dr. McLackie for their helpful suggestions and advice.

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FISSICORN TACHINIDAE, WITH DESCRIPTION OF NEW FORMS FROM AUSTRALIA AND SOUTH AMERICA

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(Communicated by E W Ferguson, M B , Ch M.)

(Eight Text-figures)

[Read 28th November, 1923]

General Remarks

Smell being the dominant special sense among insects, and its sensory organs being chiefly located in the antennae, these appendages are subject to the greatest modifications. There is, in all the orders except the lower more sedentary forms, the tendency to enlarge the antennal surface, either by increasing the number of the joints or by dilating them, or by adding sensitive hairs, or by the means of ramification or splitting of some parts. These specialisations are usually much more developed in the male than in the female, no doubt because they have some part to play in bringing together the sexes.

In the Diptera this tendency has evolved differently among the three main groups in which the order can be divided.

In the Orthorrhapha Nematocera the so-called fissicorn form is never to be observed, apparently in consequence of the fact that they possess numerous antennal joints (6-40, but usually 6-16), approximately similar to one another and arranged in a linear manner. But in certain families there are often projections on the single joints, to form so-called pectinate or bi-pectinate antennae. Without taking into consideration the elaborate structures of certain Cecidomyiidae (of *Diplosaridae* section), and of some Psychodidae (like *Brunettia* Annandale), or Culicidae (like *Lophoceratomyia* Theobald), the pectination reaches its climax among the Tipulidae. It is sufficient to recall the genera *Rhipidia* Meigen, *Gynophista* Westwood, *Cerozodia* Westwood, *Ctedoma* Philippi, *Dirhipis* Enderlein, *Scopasma* Enderlein, *Phlogyna* Westwood, *Phacelocera* Enderlein, *Osodocera* Macquart, *Ditetrastichus* Enderlein, *Ctenophora* Meigen, *Malpighia* Enderlein, *Xiphura* Brullé, *Dicladia* Brullé, and *Psilophora* Osten-Sacken. In other families there is no pectination, but its place is taken always in the male sex by the great development of bushy sensitive hairs, as in the Chironomidae and in the Culicidae; while in the more pedestrian and often gregarious *Nematocera anomala* there is neither pectination nor plumosity.

In the Orthorrhapha Brachycera there are several examples of a pectinate or bipectinate form like that of Tipulidae, as in the Stratiomyid genera *Psilocera* Wiedemann and *Isomerocera* Enderlein; or in the Xylophagid genera *Rhachocerus*

Walker and *Rhachucercella* Enderlein; or in the Tabanid genera *Elaphella* Bezzi and *Ptyocera* Giglio Tos. This is another proof of the pluriaarticulation of the antennae of all the Diptera, supported by Wandolleck (1895) and by Williston (1907). But in the main bulk of the Brachycera, the antenna being apparently composed of three differentiated joints with a terminal style, the appearance of a fissicorn form of the third joint (or of the corresponding complex) was rendered possible. This is to be observed in the Stratiomyid genera *Blastocera* Gerstaecker and *Neochauna* Williston, in the Rhagionid genus *Schusella* Bezzi, and is met very frequently in the Tabanidae. It is sufficient to recall the genera *Apocampa* Schiner, *Rhinomyia* Wiedemann, *Tabanocella* Rigot, *Hinea* Adams, *Psahda* Enderlein, *Thaumastocera* Grunberg, *Stibasoma* Schiner, *Dichelocera* Macquart, *Dicladocera* Lutz, *Ischikia* Shiraki, *Acanthocera* Macquart, *Acanthocercella* Brèthes, *Spheciogaster* Enderlein, and numerous genera recently separated from *Tabanus*. It is very important to note that in all these cases of a splitting of the third antennal joint in the Brachycera, the resulting new parts are always placed at the upper end of the true antenna, that is, of the part which bears the terminal style, and this is connected with the fact that in these Diptera the antennae are carried horizontally or erect. Another thing of importance is that in the Brachycera the presence of sensitive hairs on the antenna is very rare; a pilosity or plumosity of the style is to be observed only in *Lophoteles* Loew, *Rosapha* Walker, *Peratomastix* Enderlein, *Acrochaeta* Wiedemann and in a few other instances among the Stratiomyidae, or in *Ommatius* Wiedemann, *Allocotania* Schiner and *Emphysonera* Schiner among the Asilidae, or in *Pterostylus* Mik, *Rhagoneurus* and *Paraclius* Loew among the Dolichopodidae, and in *Ptylophyllodromia* Bezzi of the Empididae.

In the Cyclorrhapha *Athericera* pectination or splitting of the antennae is very rare, the former being even quite absent, perhaps in consequence of the small number of the joints (5-6). This fact must be considered in connection with the very frequent presence in these flies of an abundant and often very elaborate plumosity of the so-called arista (that is, of the distal part of the antenna), as is to be seen in many Syrphidae, chiefly Volucellinae, in numerous Dexinae and Sarcophaginae, in a great number of Muscidae (where it reaches its climax in the genus *Glossina*), and in numerous Acalyptrata of various groups.

It is necessary to note that this pilosity or plumosity, when present, is equally developed in both sexes (in opposition to what is the case among the Nematoocera), and that it is typically wanting only in pedestrian and gregarious forms like many Muscidae and Acalyptrata. An exception to this rule is found only in some Syrphidae and in the true Tachinidae, the latter of which have all a bare arista, but are very often powerful flyers; and it is interesting to note that a fissicorn third antennal joint among Cyclorrhapha makes its appearance precisely in these flies.

The South American Syrphid genus *Masarygus* Brèthes has a true fissicorn antenna in the male, while in the female this organ is regular; moreover, in the male antenna, the arista is quite wanting, a fact never observed in the Tachinidae. In an African genus of the same group, *Ptilobactrum* Bezzi, the third antennal joint is simple but densely plumose, and the arista is vestigial. In the European Trypaneid *Cerrocera ceratocera* Hendel, belonging to the Acalyptrata, the antenna of the male appears to be furcate, but this is due to a spinigerous process arising from the second joint, the third one being quite simple. This singular process is apparently of a protective or fighting, not sensory, nature, like the peristomial

appendages of *Elaphomyia*, etc. Singular appendages of the second antennal joint are to be observed in some "Oestrid" genera, like *Gynostigma*, etc

It is proved that in the Myiodaria the olfactory sense is located exclusively in the antennae; in these flies the third antennal joint has developed into a special olfactory sense organ. Tyler Townsend (1908, pp 33-34) is of the opinion that the arista has a protective function, as tactile organ with its hairs; and in the forms with bare arista this organ is very moveable, having the basal joints elongated to facilitate the movement. But in comparing the wonderful third antennal joint of *Talarocera* or of *Cryptocladocera* with the very elaborate arista of *Glossina*, it seems that the former with its feathering has evolved in the same way as the latter; and it may be believed that, in view of the irreversibility of evolution, the above named Tachinidae, having lost (like all their allies) the plumosity of the arista, are replacing it by feathering the third antennal joint

In opposition to what is observed in the Brachycera, the antennae being in the Cyclorrhapha carried apparently pendulous, *the new parts arising from splitting of the third joint are always placed at the underside of the antenna*, that is, of the part bearing the arista. And in contrast with the plumosity of arista, the fuscicorn condition is in Tachinidae strictly sexual, being confined to the male, and it is noteworthy that all these fuscicorn males have dichoptic eyes

It must be finally remarked that these remarkable features cannot be considered as anomalies or monstrosities, as believed by some authors, like Strobl and others. It is true that most of the species are known only in a few or even in unique specimens, but several of them have been found in great numbers, like *Dichocera lyrata* Williston, or have been profusely reared, like *Schisotachina visnerus* Thompson. The phenomenon is, moreover, a general one, having been observed in various groups of the Tachinidae, as well as in all the Zoological Regions of the World, except at present the Ethiopian one:

Historical Account

The first fuscicorn Tachinid species was described in 1830 by Wiedemann (1830, p 286) from Brazil, under the name of *Tachina nigripennis*, and curiously enough it was a female, the only female as yet known with split third antennal joint. The author is convinced that such an extraordinary form of antenna cannot be considered as a monstrosity, because it is symmetrical

The first fuscicorn Tachinid genus was described by Walker in 1853 (p 264) under the name of *Schisotachina*, as a subgenus of *Tachina* based on the furcate third antennal joint, with two species from the United States: *Tachina connecta* and *T. exul*, the former being selected by Coquillett in 1910 (p. 604) as type of the genus. These two species have been recorded under the genus *Tachina* by Osten-Sacken (1858, pp. 65-66 and 1878, p. 151), who overlooked the abovenamed subgenus of Walker

Williston in 1887 (p. 151) described as *Talarocera smithi* from Brazil, the most extraordinary fuscicorn Tachinid as yet known

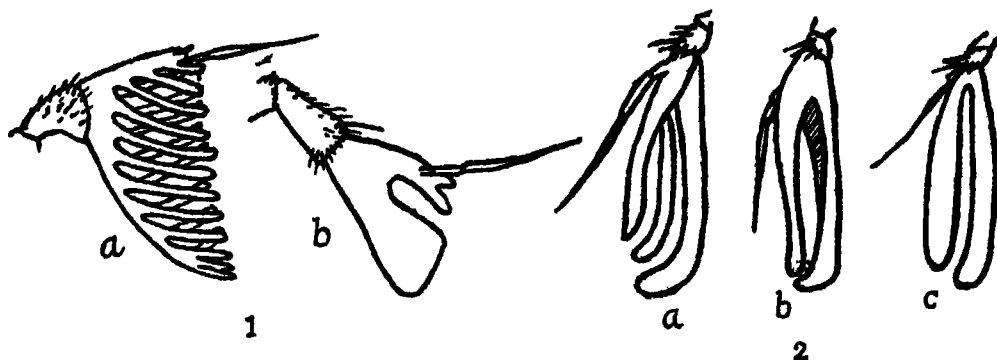
Brauer and von Bergenstamm (1891, p. 383) repeated the characters of the abovenamed species under the erroneous name of *Talarocera*, placing it in the *Tachinoidea*; and the same authors (1893, pp. 91, 146 and 193, note 75) have advanced its probable synonymy with *Tachina nigripennis* Wied.

Tyler Townsend (1892, p. 11) placed the genus *Talarocera* between *Tachinodes* and *Archytas*.

Strobl (1894, p 42) reported to have observed two female specimens of

Thryptocera exoleta Meig with furcate third antennal joint, and considered this to be an "Abnormitat," three errors in a few words

Williston in 1895 (p 29) described another remarkable American form under the name of *Dichocera lyrata*.



Text-fig 1—*Talarocera nigripennis* Wied Antenna enlarged A male, B female After Williston

Text-fig 2—Male antennae enlarged A *Neodichocera tridens* Walt, after Walton, B *Dichocera lyrata* Will, after Williston, C *Diglossocera bifida* V d W, after Van der Wulp

In the same year Mik (1895, p 101) wrote the first general article on fassicorn Tachinidae, discussing the systematic position of some genera, and accepting Strobl's conclusion about the "Abnormitat" of *exoleta* females

Still in the same year Van der Wulp (1895, p 89) described and figured a new form, *Diglossocera bifida*, bred in Java from a chrysalis of *Athyma pravara* Moore, and compared it with Williston's *Talarocera*.

In a paper of the same year Brauer (1895, p 600) recorded for the first time the genus *Schizotachina*, discussing the systematic position of *Talarocera* and of *Dichocera*

Van der Wulp in 1896 (p 103), with an additional note on his previous paper of 1895, made some corrections, accepting the conclusions of Brauer; he also (1896a, p 137) placed the genus *Diglossocera* near *Myobia* in the Tachininae

Williston (1896, p 172) has a short but important paper on fassicorn Tachinidae, giving for the first time figures of the antennae of *Talarocera* and accepting the synonymy proposed by Brauer and von Bergenstamm, and (1896a, p 12) quoted the four genera of fassicorn Tachinidae

Mik (1896, p 112), in a second article on fassicorn Tachinidae, discussed the position of *Dichocera*, and advanced the supposition that the two species of *Schizotachina* described by Walker may belong to two different genera on account of the shape of the antennal arista

Coquillett (1897) has distinguished the two genera *Dichocera* (pp 33 and 41) and *Schizotachina* (pp 38 and 41), and in the latter has placed (p 55) the second species *exul* as a synonym of the first (*connecta*); and, moreover, has described (pp 137-138) a new species *Dichocera orientalis*, but only female

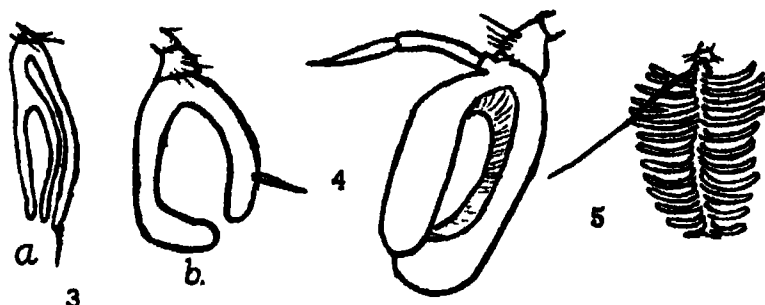
Brauer (1898, p 521) discussed again the systematic position of *Dichocera*.

Aldrich (1905) recorded all the known North American species, and (p. 481) made some important remarks about *Dichocera lyrata*.

Williston (1908, pp 30-31) gave important figures of *Talarocera*, chiefly a photograph (fig 6) of the head of the male, and, on p 370, figures of *Dichocera*.

Tyler Townsend (1908, p. 66) placed *Dichocera* in the group Pseudodexnidi, and described (p 85-86) a new genus and species *Acronarista mirabilis* (allied with *Schisotachina*) under the wrong impression that the single specimen was a female

Strobl (1910, p 139) gave the name of *Thryptocera fissicornis* to his so-



Text-fig 3—Male antennae enlarged A *Trischidocera sauteri* Vill, after Villeneuve, B *Acronarista mirabilis* Tyl Towns, right antenna of type specimen, original drawing by J M Aldrich

Text-fig 4—*Schisotachina vitinervis* Thomps, antenna of male, enlarged, after Thompson

Text-fig 5—*Cryptocladocera prodigiosa*, nsp Antenna of male, from front, enlarged, original

called "Abnormitat" of *exoleta* of 1894, considering it a new species, wrongly believing that the two specimens were females

W R Thompson (1911, p 268) described and figured a new species *Schisotachina vitinervis*, bred in numerous constant specimens of both sexes from the tineids *Aristateha roseosuffusella* Clemens and *Paratechna pinifoveella* Chamb. Moreover, he made some additional remarks on *Schis connecta* Walk (p 271), figuring its wing and recording that it was bred from *Tartix albicomana* Clem, and also stated (p 313) that the type of *Acronarista mirabilis* T T is a male and not a female

In 1912, I (p 123) recorded the fissicorn genera

Walton (1914, p 14) described and figured the important new genus and species *Neodichocera tridens* from New Mexico, allied with *Dichocera* but with more elaborate male antennae

Aldrich (1915, p 80) gave some records about his collecting of *Dichocera lyrata*

In the same year Tyler Townsend (1915, p 119) expressed the doubt that *Schisotachina vitinervis* Thomp might be the same species as *connecta* Walk, notwithstanding the different wing venation.

Villeneuve (1915, p 93) described the remarkable new genus and species *Trischidocera sauteri* from Formosa, from three male specimens with trifold antenna

Finally Tyler Townsend (1916, p 178), in a preliminary note, proposed the new genus *Dichoceropopsis* for *Dichocera orientalis* Coquillett; he gave in another publication (1916a, p 307) the characters of the genus which, however, is not considered in the present paper, because only the female is known, with a simple third antennal joint

The Genera and their Systematic Relations

For many years I have had in my collection, without a name, a wonderful Tachinid from South America, which has the male antenna conformed like that of *Talarocera*, but belongs to a different group and is, moreover, of a much smaller size. I will describe it here as a new genus and species under the name of *Cryptocladocera prodigiosa*; and on this occasion I describe also a new species of *Schisotachina* from Australia, recently received through the courtesy of Dr. Eustace W. Ferguson, Sydney. As I have also before me *Dichocera lyrata*, *Schisotachina vitinervis* and *Schiz fissicornis*, I will give a table of distinction of the known fissicorn Tachinid genera, based only on the shape of the male antenna:

- 1 (4) Third antennal joint divided in numerous (24) and paired branches
- 2 (3) Third antennal joint prominent and free, with all the branches quite single *Talarocera* Will.
- 3 (2) Third antennal joint concealed into a deep cavity, with some branches bifid at end *Cryptocladocera*, n.g.
- 4 (1) Third antennal joint divided in no more than two or three branches, which are, moreover, not paired
- 5 (8) Third antennal joint divided in three branches.
- 6 (7) The three branches of the third antennal joint are all of about the same length, arista basal and rather long *Neodichocera* Walt.
- 7 (6) The three branches of different length, arista terminal and very short. *Trischidocera* Vill.
- 8 (5) Third antennal joint divided in two branches only
- 9 (10) The upper of the two branches is much smaller than the lower one and is, moreover, slightly bifid at end *Talarocera* ♀.
- 10 (9) Both branches of about the same size and both simple at end
- 11 (14) The two branches of the third antennal joint are juxtaposed, being placed one at side of the other, arista basal
- 12 (13) Basal joints of the arista short *Diglossocera* V d.W.
- 13 (12) Basal joints of the arista elongated *Dichocera* Will.
- 14 (11) The two branches are superposed, being one in front of the other, basal joints of the arista long
- 15 (16) Arista basal and of usual length *Schisotachina* Walk.
- 16 (15) Arista nearly terminal and noticeably short. *Aoronarista* T.T.

If we take in consideration the general characters, the above differentiated 8 genera can be disposed as follows:

- 1 (10) Third longitudinal vein and first posterior cell ending considerably before the apex of the wing, hind cross-vein nearer to the bend than to the small cross-vein, forms of the New World only.
- 2 (3) The facial ridges and the very broad parafacialia quite destitute of macrochaetae, eyes bare, frons of the male broad, but without orbital bristles, antennae inserted not much above the middle of the eyes, abdomen destitute of discal bristles; species of very great size. . . *Talarocera* Will.
- 3 (2) The facial ridges or the parafacialia with bristles, eyes always hairy, species of middle size.
- 4 (9) Facial ridges not bristly, but the parafacialia with a row of macrochaetae; ocellar bristles directed forwardly, peristomalium very broad, about as broad as the vertical diameter of the eye; only two sternopleural bristles; bend of fourth vein angular
- 5 (8) Abdomen with discal macrochaetae on the middle segments
- 6 (7) Frons of the male with two pairs of strong orbital bristles; only three postsutural dorsocentral bristles; bend with a stump of vein, ... *Dichocera* Will.

- 7 (8) Male without orbital bristles; four postsutural dorsocentral, bend destitute of stump or wrinkle *Neodachocera* Walk.
- 8 (5) Abdomen destitute of discoidal macrochaetae on intermediate segments, four postsutural dorsocentral, no apical scutellar bristles, bend not appendiculate *Dichoceropis* T.T.
- 9 (4) Parafacialia without the row of macrochaetae, but the facial ridges with a row of such, ocellar bristles directed outwardly, peristomalia more narrow than the eyes, three sternopleural bristles, three postsutural dorsocentral, abdomen without discal macrochaetae on intermediate segments, bend rounded *Cryptocladocera*, n.g.
- 10 (1) Third longitudinal vein and first posterior cell ending very near the apex of wing, hind cross-vein nearer to the small cross-vein than to the bend, or about midway between them, eyes always bare, bend always rounded and not appendiculate, species of smaller size, and of the Old World only, or of holarctic distribution.
- 11 (12) Parafacialia with a row of macrochaetae, abdomen with discals on intermediate segments, arista terminal, shortened, with small basal joints, male with very small orbital bristles, cross-veins very approached together *Truchidocera* Vill.
- 12 (11) Parafacialia without row, abdomen without discal, arista not shortened, basal or subterginal, cross-veins not so approached
- 13 (14) Frons of the male without orbital bristles, antennae inserted near the middle of the eyes, arista with no distinct basal joints, parafacialia rather broad, small cross-vein near the middle of the discoidal cell *Diglossocera* V.d W.
- 14 (13) Frons of the male with two pairs of strong orbital bristles, antennae inserted above the middle of the eyes, arista with elongate basal joints, parafacialia linear, small cross-vein before the middle of the discoidal cell
- 15 (16) Arista basal and long *Schisotachina* Walk.
- 16 (15) Arista subapical and shortened *Acronarista* T.T.

Of *Acronaristopsis bahamensis* Tyler Townsend (Insec. insec. menstr., vi, 1918, p. 178) only the female is known; Dr Aldrich informs me that it is closely allied with *Thryptocera pilipennis* with three veins bristly, and that it is very unlikely that the male when discovered will be found to have a split antenna.

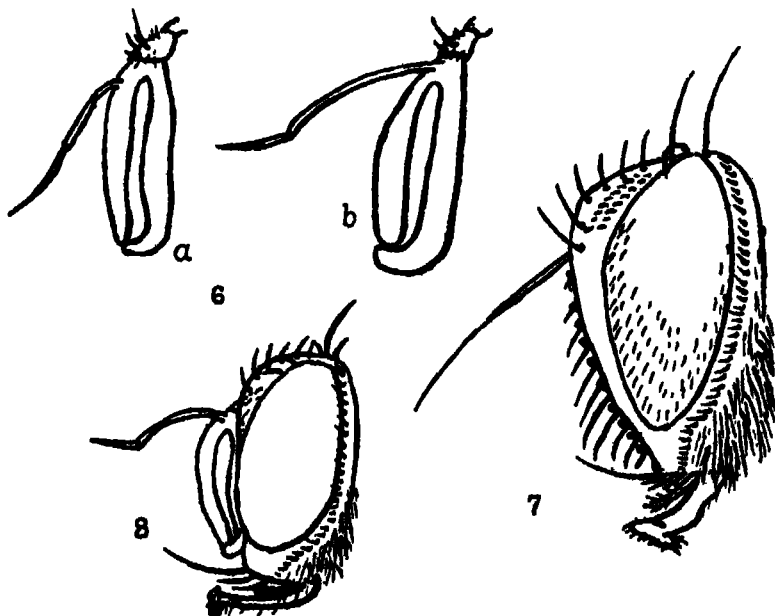
Regarding the systematic position of the above distinguished genera, it seems that *Talarocera* belongs without doubt to the Hystricinae; *Dichocera* and allies to the Germariinae or to the Baumhanerinae near *Pachystylum* (notwithstanding the ocellar bristles directed forwardly); *Cryptocladocera* to the Phorocerotinae; and all the remaining genera to the Thryptoceratinae.

The males of the known fissicorn Tachinidae have all a broad frons (with or without orbital bristles), and all have the front legs with small and short claws and pulvilli.

CRYPTOCLADOCCERA, n.gen.

Head as broad as the thorax; in front view it is about as broad as high, in lateral view it is much narrowed below, the lower border of the head being very short. Occiput very little convex, with a row of short bristles at eye border, with short bristly hairs above and with dense soft hairs below. Frons of the male moderately broad, only a little narrower than one eye; its sides are about parallel; in lateral view it is prominent on the distal half, but is rounded; it has a row of strong bristles, directed forwardly and descending with three bristles a little below the root of arista; the parafacialia have two rows of rather strong but short setulae (about 8-10 each row), which may be considered as orbital bristles; vertical

bristles long and strong, directed behind, ocellar bristles long, but thin, directed outwardly. Face broadened below, distinctly retreating, forming a broad and deep cavity, in which is enclosed the finely elaborate third antennal joint. Facial ridges completely ciliated with 10-11 strong bristles which are extended to the root of the arista and are curved downwards. Parafacialia narrow and becoming narrower below, they are quite bare. Eyes narrow, their vertical diameter being twice longer than the horizontal one, they are clothed with rather long but not dense hairs. Antennae inserted considerably above the middle of the eyes, basal



Text-fig 6 —Male antennae enlarged A *Schizotachina fissicornis* Strobl, original, B *Schizotachina fergusoni*, n sp, original

Text-fig 7 —*Cryptocladocera prodigiosa*, n sp Head of male, side view, enlarged, original

Text-fig 8 —*Schizotachina fergusoni*, n sp Head of male, side view, enlarged, original

joints short and not prominent, bristly, with one more long bristle; third joint (fig 5) feathered, with the central stem very thin and bearing 12 branches on each side, some of which are bifid at the end and all are finely pubescent, in lateral view only the extreme tips of the external branches are visible on the sides of the facial cavity. The arista is inserted at the extreme base of the stem of the third antennal joint, it is a little longer than the whole antenna, is incrassate in less than the basal half, has no distinct basal joint and is bare. Mouth border not at all prominent, with the long and decussate vibrissae placed exactly at its level. Peristomalia about as broad as long, about one-eighth of the vertical diameter of eye, they are bare, without bristles on middle, but with 2-3 bristles at lower border below the vibrissae. Mouth opening narrow and transverse; palpi normal, filiform, bristly, a little shorter than the proboscis; this latter normal, rather short and thick, with broad terminal flaps.

Thoracic chaetotaxy 2 + 3 dorsocentral, 3 + 3 acrostichal, 1 + 2 intra-alar; 3 sternopleural, placed in equilateral triangle, 6-7 hypopleural. Scutellum with two pairs of strong lateral, the terminal one stronger and longer, apical pair long and decussate, directed behind, one pair of very small and short discal.

Abdomen cylindro-conical, not broader than the thorax, with 4 visible segments, all of about the same length, no discal macrochaetae on the middle segments. All the sternites concealed. Genitalia enclosed, but rather developed.

Legs normal, with hind tibiae not ciliated, claws and pulvilli of front pair not elongate.

Wings short, without costal bristle, costa very shortly spinulose, with some longer bristles at extreme base. First longitudinal vein ending before the middle of the wing, second straight, ending a little beyond middle distance between ends of first and third vein, third vein ending before the tip of the wing, curved below before the end, with 3 bristles at extreme base above and with 2-3 more small below. Bend of fourth vein rounded but narrow, not appendiculate, first posterior cell ending before the tip of wing and narrowly open, small cross-vein placed on the middle of the discoidal cell. Hind cross-vein oblique, long, rather S-shaped and nearer the bend than to the small cross-vein. Sixth vein long but not reaching hind border. Axillary lobe prominent, alula rounded. Lower calyptrae four times longer than the upper ones, bare on disc.

Type. The following new species

CRYPTOCLADOCEIRA PRODIGNOSA, n. sp. ♂

A fly of modest appearance, looking like a normal Phoroceratine, but with the most extraordinary antenna at present known among the Tachinidae.

Type ♂, a single well preserved specimen in the writer's collection, from Surinam, received many years ago by Standinger.

♂ Length of body 9 mm, of a wing 7 mm.

Head (fig. 7) entirely black, but densely clothed with whitish dust. Frontal strip as broad as one of the parafrontalia, brownish-black. Parafrontalia white shining, peristomalia with reddish-brown spot. Basal joints of the antennae dark yellowish, third joint pale yellowish, both on stem and on branches, its delicate pubescence whitish. Arista dark yellowish, chiefly on the thickened base. Palpi yellowish, proboscis brown, with yellow flaps. Bristles and setulae black, lower occipital hairs white.

Thorax entirely black. On the back it is clothed with dark grey dust and shows two narrow parallel stripes of the ground colour before the suture, the lateral stripes are broader, but less distinct, and are broadly interrupted at suture. Pleurae densely clothed with more whitish dust, unspotted, they are a little reddish at root of wings. Scutellum densely grey dusted, unspotted. All the bristles black; setulae of back likewise black, pleural hairs black, whitish only on pteropleura. Calyptrae white, halteres pale yellowish.

Abdomen with the first segment entirely black and rather shining; the other segments are likewise shining black, but with the basal half densely grey dusted, with whitish reflexions. Setulae and bristles black, the former placed on small black dots. First segment with a pair of macrochaetae in the middle, second with a pair in the middle and one on each side; third and fourth with a complete row at hind border, even the fourth being without distinct discal. Genitalia shining black, with reddish sutures.

Legs black, the tibiae dark reddish-brown, the coxae and the femora with

whitish dust, bristles and hairs black. Front coxae with strong bristles outwardly, middle and hind tibiae with several long bristles on the middle, pulvilli yellowish, claws black, with reddish base

Wings greyish-hyaline, distinctly darkened on the anterior half, chiefly on the subcostal and marginal cell, and along the first and second longitudinal vein and at base of third. Costa and veins yellowish on the basal part, but blackish on the rest

Species of the Genus Schizotachina

This genus is very close to *Acta* R D (*Gymnoparia*, B.B.), being distinguished only by the fissicorn condition of the male, and in the American species by the single bristle at base of third longitudinal vein; the peristomalia are distinctly broader, approaching thus the condition observed in the subgenus *Thryptocera*, sens. str. of Brauer and Bergenstamm. The North American species are perhaps not congeneric with those from the Old World, which in this case need a new generic name, but I think it better at present to place them in the same genus.

The four known species, three of which are before me, can be distinguished as follows —

- 1 (4) Third longitudinal vein with only one bristle at the extreme base, sixth longitudinal vein short, always incomplete, New World species
- 2 (3) Fourth longitudinal vein complete, discoidal cell long, the hind cross-vein being placed much beyond the end of first longitudinal vein, last portion of fifth vein only a little more long than the hind cross-vein.
- 3 (2) Fourth longitudinal vein incomplete, missing beyond the bend, discoidal cell short, the hind cross-vein being about below the end of first vein, last portion of fifth vein 3 times as long as the length of hind cross-vein. *connecta* Walk
- 4 (1) Third longitudinal vein with 12-14 bristles, extending to the middle of its whole length, sixth vein longer, sometimes complete. *vitinervis* Thomps.
- 5 (6) Parafacialia rather broad and setulose on upper half, second joint of arista about as long as the first, abdomen quite black; discoidal cell short, the hind cross-vein being placed before the middle of the wing, last portion of fifth vein twice longer than the hind cross-vein, sixth vein reaching the hind border *fissicornis* Strobl
- 6 (5) Parafacialia very narrow, with only 2-3 hairs above, second joint of arista longer than the third, abdomen broadly red at base, discoidal cell long, the hind cross-vein being distinctly placed beyond the middle of wing, last portion of fifth vein only a little longer than the hind cross-vein, sixth vein ending before reaching hind border *fergusoni*, n.sp.

1 *SCHIZOTACHINA CONNECTA* Walker (*exul* Walker).—The two species of Walker have been placed in synonymy by Coquillett, but Mik was of the opinion that they are different. I have not seen them.

2 *SCHIZOTACHINA VITINERVIS* Thompson—Certainly different from the preceding, contrary to the opinion of Tyler Townsend. I have in my collection a specimen from the typical lot, numbered 2267 T

3. *SCHIZOTACHINA FISSICORNIS* Strobl.—Distinguished from *Acta exoleta* Meigen, *inter alia*, by the distinctly broader peristomalia. The species seems to be very rare in Europe; Prof. Strobl has seen only two specimens, one from Styria and one from Tirol; my specimen is also from Austria. Colbran Z. Wainwright informs me that the species has turned up in England, but only a few specimens.

I have not succeeded in finding in the literature the old record mentioned by Mik (1895, p. 42)

4. *SCHIZOTACHINA FERGUSONI*, n. sp.

Allied with the preceding, but at once distinguishable by the characters given in the key and by the different coloration.

Type ♂, a single specimen from Sydney, 21.11.1920, in the collection of the Microbiological Laboratory at Sydney, N. S. W., it was collected by Dr. E. W. Ferguson, in whose honour the species is named.

♂ Length of body 3.5 mm., of a wing 3 mm.

Head (fig. 8) in front view distinctly broader than high. Occiput black, grey dusted, with black postocular cilia and with white hairs below. Frons broad and short, broader than long and distinctly broader than one eye, the middle stripe is pale yellowish, opaque, a little broader than one of the parafrontalia, the rounded ocellar plate is grey, the broad parafrontalia are opaque grey, all the bristles are black, the ocellar directed outwardly, 6-7 interior orbital, 2 of which descend to the root of arista, 2 strong exterior orbital directed forwardly. Eyes bare, of oval shape, their vertical diameter being twice longer than the horizontal one. Antennae inserted at upper corner of the eyes, first joint hardly visible, second joint short, dark reddish, with some black bristles, third joint black, as long as the face and 4-5 times longer than the basal joints, it is divided from the base in two equal branches placed one in front of the other, but the anterior one is a little more outwardly than the other; the posterior branch is longer and thicker, and is curved forwardly below the end of the anterior one. Arista as long as the whole antenna, curved, carried horizontally, inserted at extreme base of the anterior branch of third joint, it is black, with the first joint hardly visible, the second joint very long and thick, distinctly longer than the third joint, which is acute and placed at angle. Face very broad, concave, not carinate in the middle, it is white, like the very narrow parafacialia, which are not broader than the breadth of the arista, they are bare, with only a few small hairs on upper part. Mouth border not prominent; peristomalialia about one-fourth of the eye, white, unspotted, bare, margined below with 4-5 bristles, the longer vibrissa placed at border. Palpi very pale yellowish, nearly bare, proboscis thin, with the chitinous terminal part as long as the horizontal diameter of head.

Thorax entirely black, but densely clothed with opaque grey dust, back of mesonotum short and broad, subquadrate, not striped, with black setulae and black bristles, 2 + 3 dorsocentral, but only one of the anterior and one of the posterior developed, the others very small. Pleura entirely grey, unspotted, 2 sternopleural, the posterior one very long. Scutellum one-half as long as the back and coloured like this, with 3 pairs of lateral bristles, the apical one longer and decussate. Calyptrae white, with the lower squama very long and broad, bare above; halteres pale yellowish.

Abdomen with the two basal segments reddish yellow, with a shining black spot in the middle; the two last segments shining black; 2nd, 3rd and 4th segment, moreover, with a narrow transverse band of white dust at extreme base. Venter reddish-yellow at base, shining black at end; genitalia black, enclosed. First segment without macrochaetae; second segment with one pair in the middle and one on each side; third and fourth segment with a complete row, there are no discoidal at all, even on the last segment.

Legs with reddish coxae and reddish trochanters, femora black, those of the front pair with narrowly reddish tip, those of the hind pair with reddish base,

tibiae reddish, tarsi black, with narrowly reddish base, claws and pulvilli very short, the former black, the latter whitish, hairs and bristles black

Wings short, without costal bristle, they are greyish-hyaline, with dark yellowish veins, which are more blackish towards end. Costa setulose at base. First longitudinal vein short, ending much before the middle of the wing, bare, second vein straight, its distance at end from the first being twice as long as the distance from the third, third vein straight, with 12-14 long bristles from base to beyond middle of its own length, ending at tip of wing, first posterior cell ending at tip of wing, almost closed at border. Small cross-vein placed before the end of the first vein and before the middle of the discoidal cell. Bend of fourth vein rounded. Discoidal cell rather long, the hind cross-vein being distinctly placed beyond the middle of the wing; the distance between the two cross-veins is about twice as long as the length of hind cross-vein. Fifth vein bare, extended to the hind border, with the last portion $1\frac{1}{2}$ longer than the hind cross-vein. Sixth vein not reaching hind border. Third posterior cell very broad, and axillary cell one-half as broad as it, alula rounded.

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THE OCCURRENCE OF SECRETORY CANALS IN CERTAIN MYRTACEOUS PLANTS

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(Plates xlviii-l, three Text-figures)

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Secretory canals or oil ducts differ from what are usually understood as oil glands or secretory receptacles by reason of their length, in certain genera there occur intermediate forms which, as Haberlandt (1914) points out, may be regarded as elongated sacs, i.e., glands, or as short passages. In many cases in the Myrtaceae there is a slight elongation of the oil gland in the direction of the axis, more particularly in those found in the cortical tissues, but this in no way approaches the considerable elongation which characterises the oil ducts or passages it is proposed to describe. The contents of a secretory receptacle vary considerably but, as far as the Myrtaceae are concerned, cavities containing an essential oil, that is, oil glands, are as a general rule well-developed in the leaves and cortical tissues of the young stems. Secretory canals are found in various parts of the plant and, as Solereder (1908) points out, may occur in the "pith, bast, pericycle, endodermis and primary cortex, though rarely in the wood as well." Thus of course refers only to the Dicotyledons, since the presence of oleoresin passages is a well-known feature of certain coniferous woods. Resin passages are also a characteristic of Dipterocarp woods (Schneider, 1916), being well-marked in the genera *Shorea*, *Pentacme*, *Hopea*, etc. De Bary (1884) mentions also certain Monocotyledons and Pteridophytes in which secretory passages occur.

Solereder (1908), however, makes no mention of the presence of secretory canals in any of the Myrtaceous genera though, as pointed out in a previous paper (Welch, 1921), undoubtedly oil ducts occur in certain species of the *Corymbosae* group of the Eucalypts, and also in *Angophora lanceolata* Cav. In the present investigation, oil ducts are also recorded in certain species of the genera *Tristania* and *Syncarpia*, but in both cases a very much more highly developed system of passages occurs than is found in *Eucalyptus* and *Angophora*, since they occur not only in the medulla, as obtains in these two genera, but also in the cortical tissues. So great is the development of oil ducts in the secondary phloem, that is, bark, of the Turpentine (*Syncarpia laurifolia* Ten.), that it is without doubt a most important factor in rendering the piles, for which the timber is very largely used, immune from the attacks of Teredo. Without the bark, Turpentine is no more resistant to Teredo than many other hardwoods. It is thus evident that these ducts possess considerable economic importance in this respect.

Syncarpia and *Tristania* are closely related genera, being placed consecutively in the sub-tribe *Metrosidereae* of the *Leptospermeae* by Bentham and Hooker (1862-67) and also in the tribe *Leptospermeae* by Engler and Prantl (1897). Although the two genera differ markedly in the morphology of the flower and fruit, yet the timbers of Brush Box, *Tristania conferta* R Br and Turpentine, *Syncarpia laurifolia*, resemble each other closely in many respects.

An examination of material of *Tristania conferta* shows the presence of numerous ducts, extending for considerable distances, branching and following the principal reticulations of the lateral veins, they are particularly prominent in the midrib of the lamina and in the petiole of the leaf, as well as in the cortical and medullary tissues of the stems, and fruit and flower pedicels and peduncles.

In a transverse section of a leaf bud it is seen that the ducts are first developed towards the lower or abaxial surface of the leaf, outside the vascular tissue and about midway between the outer portion of the phloem and the epidermis. They are most numerous and highly developed near the midrib and, although found to accompany the primary veins, are longer and more prominent in the former case. In more mature leaves ducts can be traced within the vascular bundles which, in the case of both *Tristania conferta* and *Syncarpia laurifolia* and in the *Corymbosae* group of the *Eucalypts* and *Angophora lanceolata*, form practically a complete ring, and also towards the abaxial surface. The prominence of the ducts in the abaxial leaf tissues, that is the outside of the young leaf bud, when compacted together, seems to indicate that their function is primarily one of protection and, moreover, as growth takes place, further duct development is found on the upper and lower sides of the smaller vascular bundles forming the lateral veins.

Plate xlviii, fig 1 shows a transverse section of a leaf bud near the apex, in which are three pairs of leaves in different stages of growth. The outer pair are cut near the junction of the petiole and lamina and, in common with the second pair, possess well developed ducts, approximately five in number, situated towards the lower surface. In all the leaves, even the smallest, it is easily possible to trace the arrangement of the bicollateral vascular bundles of the midrib which form a more or less complete ring and, even at this stage, it is possible to detect a slight indication of the development of secretory passages in the medulla. In the innermost pair of leaves the ducts are not so clearly defined as in the others and are fewer in number. In the section figured there is no clear evidence of the presence of oil glands, though these do occur nearer the epidermis, even in the very young leaf apices before the development of the ducts. It is possible to trace the course of a single duct from the stem into the petiole and lamina of the leaf without any evidence of discontinuity, such as is evident in certain *Eucalypts* and *Angophora lanceolata* and, moreover, undoubted branching occurs, one duct dividing into two, the branches gradually diverging so that a few millimetres from the point of junction they are comparatively widely separated. It is also possible to find short ducts which arise independently and extend only for a few millimetres or less, and have apparently no connection with any others. In young leaves and stems it is evident that the ducts are not all developed at the one time, since, in one section, all stages from practically mature oil ducts to immature cell groups can be found.

The numerous dots and short lines around and between the leaves in the figure represent sections of the innumerable hairs found in the leaf-bud.

The branching and continuity of the ducts is also clearly brought out in a longitudinal section of a leaf-bud. There is a gradual increase in size of the

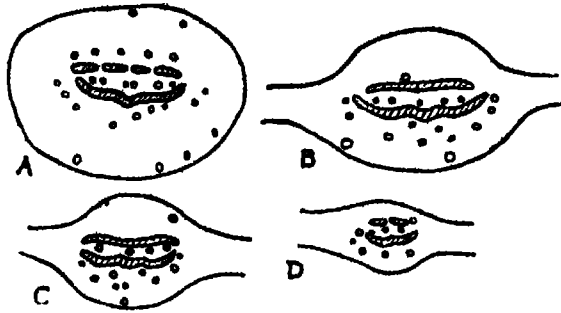
ducts towards the lower part of the bud, the average diameter ranging from 0.02 mm to 0.07 mm in young tissues. Plate xlviii, fig. 2 shows a slightly oblique longitudinal section of a leaf-bud of *Tristania conferta*. To the right are numerous stem ducts, and above is portion of a leaf blade and petiole in section, with one very prominent duct. In other sections of the same leaf-bud, this particular passage was found to link up with a stem duct and in the opposite direction could be traced almost to the leaf apex. To the right of this duct is a short vertical canal which serves as a connection between the petiole duct and those of the stem. At the bottom of the section is portion of the petiole and lamina of a leaf corresponding in age and growth to that at the top, but it is cut near the edge and does not show much evidence of ducts, except a short length near the apex. Between the upper and lower leaves in the same section is portion of an inner leaf showing several very prominent ducts. The structure of the sample hairs forming the leaf-bud investiture is more clearly shown than in the preceding section.

A more highly magnified longitudinal section of the same leaf-bud is shown in Plate xlviii, fig. 3. Two of the ducts are cut somewhat obliquely and appear as elongated elliptical cavities, whereas they actually extend for a considerable distance. The most important point, however, is the very clear evidence of branching which is noticeable towards the bottom of the figure. The two uppermost prominent horizontal passages are in the leaf midrib, as are also the less prominent lower horizontal ducts, which are marked by elongated zones of closely compacted cells with dense protoplasmic contents. The almost vertical duct which joins the right lower midrib duct is following the course of one of the principal lateral veins. The vascular bundle corresponding to this duct is not seen, since the section passes below it. Towards the lower left-hand corner is portion of one of the primary veins, in this case cut clear of the adjoining duct, though there is a trace of one at the extreme bottom edge of the figure. There is no sign of oil glands in this section. The branching of ducts and their ramification into every part of the leaf is a characteristic feature of this species of *Tristania*. It is found that normally two ducts accompany each of the principal primary veins, one being above and the other below. These ducts are comparatively small, measuring only about 0.04 mm. in diameter. Although oil glands are usually large and well-developed in the spongy mesophyll of the leaf, no connection has been found between them and the ducts, the latter, with one exception, having only been observed in conjunction with vascular tissue. In tracing the course of these small secretory passages it is found that they undoubtedly link up with the main ducts which run above and below the corresponding vascular bundles of the midrib. Ducts have not so far been detected corresponding to the smaller leaf veins.

Plate xlviii, fig. 4 shows a transverse section, at right angles to the midrib, of a portion of a young leaf of *T. conferta*. Towards the left is a small bicollateral vascular bundle cut somewhat obliquely, but below and above it and marked "d" are two small secretory ducts. The larger oil glands, measuring 0.14 mm in diameter, stand out prominently in comparison; to the right is a small leaf vein, also cut obliquely, but there is here no evidence of corresponding secretory ducts.

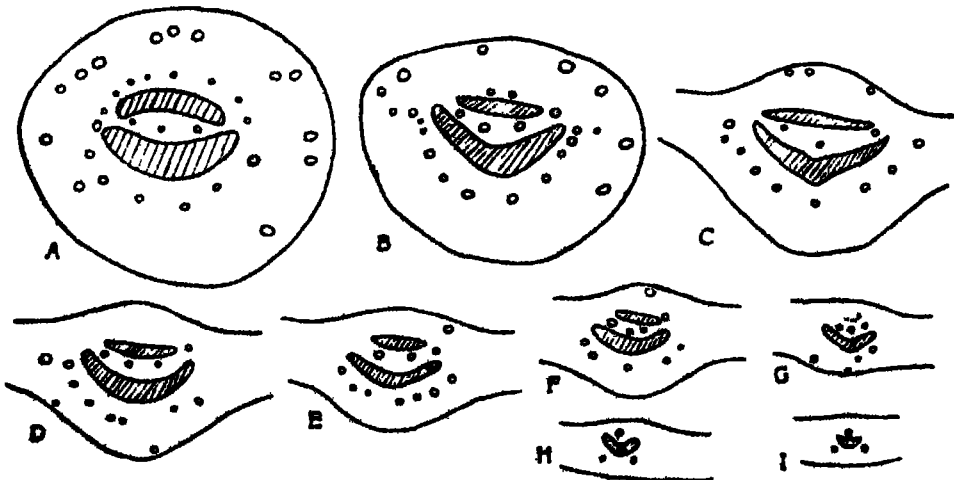
In the mature leaf the ducts are particularly prominent in the midrib and, on cutting the lamina transversely, the exudation is most marked at that point, whilst that from the smaller primary vein duct is necessarily scanty. As in the very young leaves, ducts are much more numerous in the loose parenchymatous

tissue towards the abaxial surface and in the thin-walled tissue between the two almost parallel zones of bicollateral vascular bundles than towards the upper surface. It seems evident, therefore, that there is practically no new duct development during later leaf growth. Text-figure 1 indicates the relative positions of the xylem, secretory ducts and oil glands at different 10 mm intervals in the petiole and midrib of a leaf 40 mm long. In section (a), which cuts the petiole



Text-fig. 1—Transverse sections of a young leaf of *Tristania conferta* (petiole and midrib) showing arrangement of the secretory ducts, oil glands and vascular tissue (x 20).

transversely, there are six peripheral oil glands. Within this are five ducts above the vascular bundles, six between the vascular zones, and nine below it. Fig. 1b is cut across the lower portion of the lamina, and shows two oil glands towards the lower epidermis, and a very marked reduction of the adaxial ducts from five in (a) to one. There is one less medullary duct, and the same number of abaxial ducts. Fig. 1c again shows two oil glands, but the ducts towards the upper sur-



Text-fig. 2—Transverse sections of the petiole and midrib of a mature leaf of *Tristania conferta* showing the arrangement of the secretory ducts, oil glands and vascular tissue. (x 17).

face have completely disappeared; there is a reduction in the number of the lower ones. Fig. 1d is near the leaf apex and indicates a rapid diminution in the size of the upper row of vascular bundles. There are no adaxial ducts, four medullary ducts and five towards the lower surface. Text-figure 2 shows a correspond-

ing relationship in a mature leaf 180 mm in length, the sections being taken at 20 mm intervals. (a) shows the petiole section near the junction with the stem, the peripheral oil glands are prominent. There are eight small ducts above the vascular bundles, three ducts between the vascular zones, and seven below. In Fig 2b the adaxial ducts are reduced to two, the number in the medulla is four, and below there is an increase to thirteen. This increase may be due to branching of ducts already present or to short isolated ducts which, however, may not extend for any distance. Fig 2c shows the total disappearance of the adaxial ducts as in the immature leaf (Text-figure 1) with three medullary ducts and nine towards the abaxial side. In Fig 2d there are three medullary ducts, and a decrease in the abaxial ducts to eight, with two oil glands, also towards the lower surface. To the right is a single duct, evidently extending to a lateral vein. Fig 2e still shows three medullary ducts, but there is a further reduction to seven in the lower group. Towards the upper surface is an oil gland. Fig 2f again has four medullary ducts, but the lower ducts are still further reduced in number to five. Fig 2g shows a marked reduction in the upper vascular bundle zone, and a corresponding decrease in number of the oil ducts to three above the xylem and two below. Fig 2h and 2i are approaching what obtains in the principal costal veins, there being a single bicollateral vascular bundle with one duct above and two below.

Text-figure 2 shows to what a great extent secretory ducts are developed in the leaf, and how persistent they are, even at the extreme leaf apex. They are apparently formed principally in conjunction with the lower vascular zone, since those corresponding to the upper zone, that is, those developed towards the adaxial surface, are not persistent far from the petiole, provided that they even reach the lamina.

There is evidently no definite number of ducts present in the various portions of the plant in which they occur. Those found between the vascular bundles are as a general rule, fewer in number and smaller in size, some indication of this being given by the fact that the exudation is less in the centre than towards the periphery of the midrib, when the latter is cut transversely.

A transverse section of the midrib of a mature leaf of *Tristania conferta* is shown in Plate xlix, fig 7. Towards the lower surface are nine ducts, some of which are not particularly conspicuous in the loose parenchyma, five ducts are between the vascular bundles and towards the upper surface of the leaf. Towards the right is a typical oil gland, approximately equal in size in transverse section to the ducts. The average diameter is about 0.06 mm.

In the leaf of *Syncarpha laurifolia* a somewhat similar arrangement of the secretory ducts is found, except that there is a much greater development towards the lower surface of the midrib than elsewhere. A transverse section of the midrib and adjacent tissues of the leaf is seen in Plate xlix, fig 8. The ducts, measuring up to 0.07 mm. in diameter, correspond in size to those of *T. conferta*, but they are more conspicuous, although fewer in number. In this instance, there are five ducts towards the abaxial surface, four between the two almost parallel zones of bicollateral vascular bundles and one towards the upper surface. It is at once evident from a comparison of Plate xlix, figs 7 and 8 that the relative importance of the ducts is much greater in the case of *Tristania conferta*. Although small ducts accompany the principal primary veins in the leaves of *S. laurifolia*, these again are not so prominent as in the other species. Passages measuring 0.02 mm. in diameter were found near the intramarginal veins, but they do not always occur in this position. The intramarginal vein of *T. conferta* is usually accompanied by two ducts, one above and the other below the vascular

bundles, but occasionally by one or two short lengths often not extending for as much as 1 mm. In the lateral veins, although it is normal to find one duct above and one below the vascular bundle, in some only one duct is developed below, and in others no ducts whatever were traced.

Surrounding young terminal leaf buds of *T. conferta* are numerous thin imbricate bud scales which fold over and enclose the growing shoot. As growth proceeds these become brown and finally drop off. In transverse section (Plate xlviii, fig. 5) these kataphylls appear as thin structures, tapering gradually and becoming very fine towards the edges. There is no differentiation of the tissues into palisade and spongy mesophyll and the vascular strands are very small. The striking feature is the enormous development of the secretory ducts, forming a great contrast to the comparatively few present in the inner group of foliage leaves in the same section. These ducts measure up to 0.07 mm. in diameter in the sections examined, whereas those in the corresponding foliage leaves are about 0.04 mm. in diameter. Although many of the ducts are in close proximity to the vascular strands, this is not true of the majority. No evidence of oil glands was found in these kataphylls. Those which appear to be small cavities (Plate xlviii, fig. 6) are in reality passages which are cut transversely. This section passes longitudinally through the outer portion of a leaf bud, cutting one scale practically in a median plane, parallel to the surface. It is evident that there is considerable branching and ramification of the passages, which end blindly, gradually becoming smaller towards the bud-scale margins and tip, these being devoid of ducts. This is evidenced in the scale tip section on the left of figure 6 (Plate xlviii), the narrow portion being part of the broad scale on the right, which is completely folded over.

Although the development of the secretory oil ducts is a feature of the leaf, it is in the stem that they become most conspicuous. They are not found near the epidermis, but both in the medulla and the cortex approach close to the phloem. As in the *Eucalypts*, numerous cortical oil glands found close to the epidermis often have the longest axis longitudinally directed, but do not extend for any distance, and can be easily distinguished from the true ducts. The parenchyma of the cortex is large and thin walled, the cells being smaller towards the epidermis and also towards the outer phloem of the conducting strands. From their position it seems probable that they are developed from the ground tissue. Plate xlix, fig. 10 is a transverse section of a 3 mm. stem of *T. conferta*, showing thirty ducts developed in the medulla and fifty-eight in the inner cortex. These figures indicate how extensively ducts are formed; their relative importance in this genus and in the genus *Eucalyptus* is evidenced by the fact that in the latter the typical number of similarly constituted ducts is four, all of which are within the medulla. It is apparent that they are much more numerous than oil glands. The ducts measure 0.050 mm. mean diameter in the pith, 0.04 mm. minimum, 0.10 mm. maximum. In the cortex the average diameter is 0.06 mm., minimum 0.02 mm. maximum 0.085 mm., in the specimens examined. In older stems of *T. conferta*, as would be expected, there is approximately the same number of ducts in the medulla as in the younger stem, although they had in some cases increased in number somewhat in the cortex. A transverse section of a three-year stem measuring 5 mm. in diameter is shown in Plate l., fig. 11. Portion of the xylem, the intraxylary phloem and the pith with its numerous oil ducts are shown, all of the latter being distributed near the phloem. The average diameter of the ducts is 0.08 mm., the number present being approximately the same as was found in the section of the smaller stem (Plate xlix, fig. 10).

In longitudinal sections of the stem of *T. conferta* the difference between the

sub-epidermal oil glands and the more deep-seated oil ducts is apparent. Although the oil glands are somewhat extended longitudinally (Plate I, fig. 12) they are quite distinct from the greatly elongated ducts or passages. These latter are undoubtedly in many cases continuous throughout the leaf into the stem, thus the length may be at least 150 mm, though they probably extend for a much greater distance. The section shown in Plate I, fig. 12 passes principally through the cortex, just reaching the outer part of the phloem, the two well marked ducts which are cut somewhat obliquely are therefore cortical.

In *Syncarpia laurifolia* the stem ducts are usually fewer in number than in *Tristagma conferta*, and although there is apparently little difference in their development and mode of occurrence in young stems and leaves, in older stems there is a very marked alteration. It has been pointed out that in young stems of *T. conferta*, cortical ducts are particularly conspicuous, but in older stems, on account of the development of the phellogen below the epidermis, the outer cortical tissues are exfoliated. Subsequent development of successive meristematic tissues towards the cambium causes the total removal of all the cortex, and finally the outer portion of the phloem. Thus, in sectioning a young branch of which the bark is somewhat scaly, there is no trace of oil ducts left in the outer tissues, although those occurring in the medulla may still function. For example, in a stem of *T. conferta* 23 mm in diameter, the total thickness of tissue outside the cambium was 1.2 mm but the whole of the cortex had been removed, and there was no sign of secretory ducts or cavities. Chlorophyll was present to a depth of 0.6 mm from the outside. In a stem 4 mm. in thickness, the cortex and secondary phloem measured 0.6 mm. The epidermis was still intact and secretory ducts were seen in the cortical tissue. In another stem 4 mm. in diameter, the epidermis had disappeared together with the outer cortex. The total "bark" thickness from periderm to cambium being 0.45 mm. A few ducts were present just bordering on the phloem, but not occurring within it. In a stem of 8 mm. diameter with a bark thickness of 0.75 mm no evidence of ducts was found.

An examination of the mature bark 8 mm thick showed numerous large bast fibre zones measuring, in transverse section, up to 0.4 mm x 0.6 mm. with the longer axis at right angles to the medullary rays. Numerous pitted stone cells occur, either isolated or in short rows. There is no evidence of oil-containing secretory cavities. It seems obvious therefore that there is no subsequent development of ducts in the secondary phloem.

A section of a mature stem of *Syncarpia laurifolia*, however, reveals a very pronounced difference in the disposition of the ducts in this species when compared with *T. conferta*. This is due to their development in the secondary phloem. In a stem 5 mm. in diameter four ducts occurred at the corners of the medulla measuring 0.15 mm. along the longer axis, being somewhat elliptical in cross-section. Those present in the cortex were somewhat smaller, measuring about 0.10 mm in diameter. In small branches 64 mm. in diameter, the thickness of the inner bark, i.e., the secondary phloem, extending from the cambium to the innermost abscission layers, was 2.5 mm. Ducts measuring 0.055 mm. in diameter were found within 0.04 mm. of the cambium. It is therefore evident that the differentiation of the secretory passage must occur within a very short time of the division of the cambial meristematic cells. A transverse section of a 64 mm stem, showing portion of the secondary phloem is shown in Plate I, fig. 13. At the top is one of the abscissa phelloids which are formed in concentric rings in the outer tissues. These abscissa layers, which form thin scales in the mature bark, consist of a zone of five or more rows of thick walled brown-coloured

tabular cells, much compressed radially and apparently belong to the "passive" type described by Von Höhnelt*. Very evenly distributed throughout the phloem are the numerous secretory ducts which, though somewhat larger towards the absciss layer, are yet quite large near the cambium at the bottom edge of the figure. Another rather striking feature of the bark of *S. laurifolia* is the small regularly arranged bast fibre zones, whereas in *T. conferta* the zones are very large and irregular.

The mature bark of *S. laurifolia*, is somewhat furrowed and separated concentrically by numerous more or less persistent thin brown plates, which correspond to the absciss phelloids already described. In section, a bark 20 mm thick showed an inner living secondary phloem tissue of 5 mm and outside this eight concentric zones separated by the thin absciss layers, making up 15 mm in all. There is a marked increase in the size of the inner zone of thin-walled phloem cells towards the last formed phellogen, and thus enlargement becomes more pronounced in the outer zones after the development of the absciss layers. Thus, cells measuring 0.018 mm along the radial axis become 0.18 mm in length. There is practically no corresponding increase in size in a longitudinal direction. These enlarged cells are particularly loose and spongy, and it is due to their disintegration that the bark becomes roughened on the outside. The small fibre groups are, of course, unaltered during this enlargement, and persist during the breaking down of the tissues. There is little or no alteration in size of the oil ducts, which averaged about 0.09 mm in diameter in the specimens examined. The contents in the outer portion of the bark were slowly soluble in 100% alcohol. The increase in size of the surrounding thin walled cells results in a consequent reduction in the number of oil ducts per sq mm. These in the inner portion (Plate 1, fig 13) are, as in the younger branch, very evenly distributed and average 5.2 per sq mm, whereas in the outer portion the average is reduced to 0.9 per sq mm. Here also (Plate 1, fig 14) the fibre zones are small, with the longer transverse axis directed tangentially, and the medullary rays are uniseriate. A somewhat thinner bark measuring 8 mm in thickness showed an inner zone of 3 mm and three concentric outer zones measuring 5 mm. The absciss phelloids were about 0.12 mm thick, and consisted of about ten rows of cells, otherwise the structure was identical with that already described. The average number of ducts per sq mm was 3.3 in the inner portion, maximum 4.3, minimum 2.6, with a mean diameter of 0.075 mm, the minimum being 0.06 and the maximum 0.10 mm.

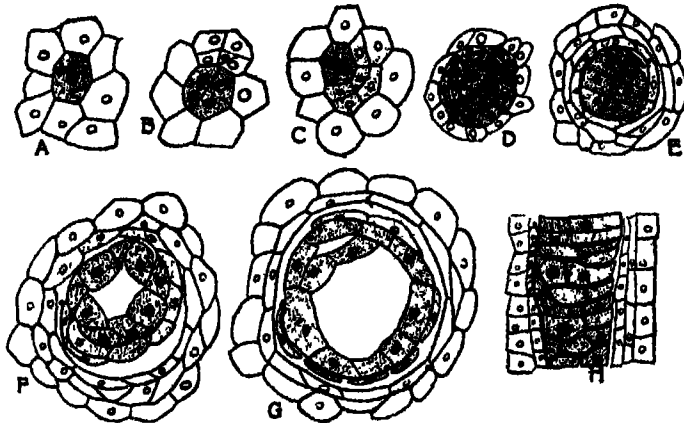
An examination was made of the roots of seedlings of *Tristania conferta*, but no evidence of the presence of ducts, even in roots measuring only 0.35 mm in diameter, was found. Neither were they observed in the swollen nodules at the base of the stem. There was, however, a great difference in the structure of the roots of *Syncarpia laurifolia*. On cutting them transversely there was a very pronounced exudation, yellow in colour, and definite secretory ducts were found in roots measuring 0.3 mm. in diameter. In larger roots the development in the secondary phloem was much more prominent than in the stems, the ducts, up to 0.15 mm. in diameter, being larger and more numerous.

Development—From an examination of leaf buds it is found that oil glands are developed at an earlier stage in the ontogeny of the tissue than are the oil-ducts. Thus in leaves of *Tristania conferta* measuring 0.16 mm. in diameter,

* Haberlandt gives this reference as Sitzb Wien, 76, 1877. It was not available.

secretory cavities were present, but there was no evidence of the passages. Similarly, in leaves 0.75 mm in diameter, no passages were observed, although oil-glands were comparatively numerous. A single duct measuring 0.04 mm in diameter near the midrib, and four smaller ducts, each 0.02 mm in diameter, corresponding to the lateral veins, were found in a leaf 1.35 mm in breadth.

The early stages of development are shown in Text-figure 3. It seems evident that the division of more than one row of cells of the ground tissue occurs, though it is possible to obtain a stage (3a) in which a single division has taken place. This is followed by, or is simultaneous with, the division of certain adjoining cells (3b and 3c), resulting in the formation of a large inner cylindrical mass of small glandular cells (3d, 3e) with densely granulated protoplasmic contents, surrounded by several layers of cells with less dense contents and flattened so that the longer axis is tangentially directed in transverse section. In longitudinal section (3h) the inner zone of cells is not elongated in the direction of growth in the early stages, although the outer zone becomes definitely so. As growth proceeds the inner cells enlarge and separation occurs, thus showing evi-



Text-fig. 3—Stages in the development of the secretory ducts in *Tristagma conferta* (a-e, h, x 300, f, g x 400).

dence of an initial schizogenously development (3f). The inner cells tend to become flattened in a tangential direction and are also somewhat elongated vertically, it is evident that they are of a secretory character, and form an epithelial layer (3g) lining the duct. In tracing the development of the passage it is apparent that disintegration of the innermost secretory cells occurs; thus there is evidently a schizogenously stage, followed by, and in many cases contemporaneous with, a lysigenously one, the mature passage being therefore schizolysigenously, as occurs also in other Myrtaceous plants. A slight partial separation of the inner cells is shown in Text-fig. 3g, although many ducts have been observed in which there is a complete separation of an inner ring of glandular cells. In many cases there is no evidence of an epithelial layer in the ducts in older stems and leaves, though the cavity is sometimes partially or totally occluded with more or less disintegrated thin walled cells.

It has been shown that no evidence of ducts has been found in the vascular tissue of *Tristagma*, whereas in certain species of *Syncaesia* the development in the secondary phloem is very prominent. No trace of passages has been observed in the phloem of the leaf, either in the lamina or petiole. Small ducts sometimes occur in the intraxillary phloem of the stem but they are not common and

may only extend for a short distance. As far as has been observed the mode of development in *Syncarpia* is similar to that of *T. conferta*.

Exudation—On cutting a stem or leaf of *T. conferta* there is usually a milky-white exudation resembling in appearance a latex, whilst *S. laurifolia* gives a clear or almost so, yellow to yellowish-brown liquid. Alkannin in 50 per cent alcohol gives a very definite reaction for oily bodies in the ducts of cortex and pith in the former species, and also in the cortical oil glands, the contents being soluble in 100 per cent alcohol. Treatment of a portion of the milky exudation with alkannin showed the presence of numerous small oil globules varying considerably in size. The diameter of these was usually between 0.001 mm. and 0.05 mm. On exposure to the air coalescence takes place to some extent, the droplets becoming larger, and the whole forming a more or less clear brownish coloured viscous liquid which gave all the reactions for an oily body. In young stems the exudation is more milky than that from older stems which is often practically clear. On cutting the young stems and petioles the exudation is usually more copious from the pith ducts.

It is evident that the oil is present as the disperse phase of an emulsion, the other phase being of a colourless transparent watery nature. On treatment with absolute alcohol, a honeycombed residue is obtained, after solution of the oil globules, which is insoluble in ether or chloroform. The exudation evidently corresponds to the "gum-resin" of De Bary (1884), which he records in *Allium*, *Sambucus*, *Cinchona*, *Acer*, *Convolvulaceae*, *Sapotaceae*, etc. These ducts do not correspond in structure or development to the laticiferous vessels or cells, nor are the contents a typical latex.

The exudation from *S. laurifolia* differs entirely, as far as has been observed, from that of *T. conferta*. It is clear and almost soluble in 90 per cent alcohol, finally so in 95 per cent, leaving a small colourless residue. It flows freely when young stems are cut, and is evidently an oleo-resin, alkannin giving the colouration for these bodies. Since the ducts occur in the bark a small quantity of the resin can be obtained by cutting it. In the inner portion of the bark the contents of the ducts are pale yellow in colour, in the outer layers, after enlargement of the parenchymatous cells, the oleo-resin is still persistent, though somewhat less soluble in alcohol.

An examination was also made of certain other species of the two genera which were available, with the following results—

Tristania laurina R.Br.—No ducts observed either in the pith or cortex of the stems nor in the leaf, though oil glands were present in the latter. There was no sign of development in the phloem. It is interesting to note that a double zone of vascular bundles was not found in the leaves (cf. *T. conferta*). A similar arrangement of the vascular tissue in two almost parallel areas occurs in the midrib of those Eucalypts in which ducts are present and *vice versa*; these do not occur where there is a single row of vascular bundles.

T. nerifolia R.Br.—No oil ducts were found in the pith or cortex, though oil glands occurred in the latter. None were found in the leaf.

T. exiliflora F.v.M.—A species from Northern Australia. Very scanty herbarium material was available, but no oil ducts were observed.

T. lactiflua F.v.M.—Also a Northern Australian species. Here again very scanty herbarium material showed no evidence of ducts. Mueller, however, in his original description (Fragm., i.) states that "Ramuli fractura lacte acri amaro scaturit". From this it is evident that further investigation is necessary.

T. suaveolens Sm.—Ducts measuring up to 0.11 mm were found in the pith, usually six in number. Numerous ducts were also present in the cortex. In the leaf they were developed to a lesser extent in the medulla between the vascular bundles than outside them. None were found in the secondary phloem.

Syncarpia subargentea White.—Only a small amount of material was available for examination, but as far as could be determined no oil ducts were found in the leaves or stems, either in the medulla or cortical tissues.

Syncarpia leptopetala F & M.—No indication of ducts was found in the pith or cortex of the material examined. Oil glands were numerous and well-developed in the cortex. No ducts were observed in the leaves.

S. Hillii Bailey.—Numerous ducts measuring up to 0.08 mm in diameter were found scattered in the pith of young stems. In the secondary phloem they were smaller and not numerous, measuring up to 0.05 mm. In the leaf they occurred both above and below the vascular tissue of the midrib, though principally towards the abaxial surface, as in *S. laurifolia*. Three or four also occurred between the two almost parallel rows of vascular bundles.

With regard to the species of *Tristania*, both *T. conferta* and *T. suaveolens* are grouped in the *Lophostemon* section by Benthham (1866), *T. nerifolia* is placed in the *Nerophyllum* section and *T. lactiflua*, *T. exiflora* and *T. laurina* in the *Eutristanias*, apparently only those species of the group *Lophostemon* contain oil ducts. Material of *T. pudicoides* and *T. umbrosa* belonging to the *Eutristanias* was not examined.

In the genus *Syncarpia* we have two species with ducts, *S. laurifolia* and *S. Hillii*. Material of *S. subargentea* was scanty, but as far as could be observed did not contain them. *S. leptopetala* differs very much in morphological characters from *S. laurifolia*, so much so that Maiden (1904) suggests that the former species should belong to the genus *Metrosideros* as *M. leptopetala*. Mueller (1889) synonymised the genus *Syncarpia* under *Metrosideros*. An examination of a New Zealand species, *Metrosideros tomentosa* A. Rich, revealed no evidence of secretory passages, though numerous oil glands were observed in the cortex. From an anatomical point of view, therefore, there seems no objection to removing *S. leptopetala* from the genus *Syncarpia*, and placing it under *Metrosideros*, with which it possesses undoubted affinities.

In comparing these ducts with the only other Myrtaceous plants in which they have been recorded, namely the *Corymbosae* group of the *Eucalypts* and *Angophora lanceolata*, certain striking differences are to be noted. Whereas in the former species they occur only in the medulla of the stems and petioles and portion of the laminae of the leaves, here they are not only found in the midrib but also accompany the lateral and intramarginal leaf veins. The development in the pith is also very much greater, particularly in *Tristania conferta*, and there is also an extensive production in the cortex whilst in *Syncarpia laurifolia* and *S. Hillii* they occur in the secondary phloem and to a slight extent in the intraxylary phloem. In the former genera also there is no continuity between the ducts of the leaf and stem, in these types we have undoubted continuity and, moreover, extensive branching, a feature not observed in the others. There is also a great difference in the mode of development, since in the *Eucalypts* the passage is formed by the linking up of a series of short secretory cavities, whereas here a continuous development, due to the division of a row, or rows, of meristematic cells, is found.

The most vulnerable part of the plant is undoubtedly the young shoot, and, if the function of these ducts were protective, we would expect to find

them in a position in which they could resist attacks on the young buds. It has been shown to what an enormous extent they are developed in the kataphylls protecting the leaf buds in *Tristama conferta*. From their presence there they are obviously not acting as storage reservoirs, since the kataphylls are deciduous, nor from their arrangement can they be interpreted as being purely conducting organs. It has also been shown that they occur in the leaf bud, always towards the outside, and in conjunction with the vascular tissue, similarly in the young stem they occur in the cortical tissues and in the medulla. In every case their position indicates a relationship to protection. Their occurrence in the secondary phloem to an enormous degree and the fact that oleo-resin is present in the outer layers of bark after separation from the inner living portion by a series of absciss phelloids, discredits the theory that they are for storage purposes. Apart from the purely protective role, the exudation may, as pointed out by Haberlandt (1914) undoubtedly serve to cover up wounds.

Summary

Secretory canals or oil ducts occur in certain species of the genera *Tristama* and *Syncarpia*, not only in the medulla, as in a number of species of *Eucalyptus* and in *Angophora lanceolata*, but also in the cortex.

In *Syncarpia laurifolia* a very marked development of the oil ducts is also found in the secondary phloem of the stems and roots, but they do not occur similarly in the genus *Tristama*.

In leaf buds, oil glands alone are present in very young leaves, measuring up to about 0.75 mm. in breadth, but subsequent development of the secretory passages takes place towards the abaxial surface.

Not only are ducts present in the midrib of the leaf, but they also accompany the principal lateral veins and the intramarginal vein, the normal number being two, one being above and the other below the vascular tissue.

The ducts are very much more numerous than in the genera *Eucalyptus* and *Angophora* and, moreover, may extend from the lamina of the leaf through the petiole into the stem—this does not occur in the former genera.

Development takes place through the division of certain rows of cells in the ground tissue, producing an inner core of glandular cells. Separation of these occurs, followed by disintegration to a greater or lesser degree, the mature duct being therefore schizolysigenous in character.

The exudation from *Syncarpia laurifolia* is usually clear and transparent and is oleo-resinous, whereas in *Tristama conferta* the exudation is milky, the oil being present as an emulsion.

The function of the oil ducts is probably protective, particularly since they are found in close proximity to the vascular tissue, and to an enormous degree in the kataphylls protecting the leaf-buds, and also in the secondary phloem of certain species, but the question as to whether such ducts were originally protective in their origin and evolution needs further enquiry.

I am indebted to Professor A. A. Lawson, D.Sc., for his kindly criticism.

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EXPLANATION OF PLATES XLVIII-L

Plate xlviii

- 1 Transverse section of young leaf bud of *Tristania conferta* near apex, showing development of oil ducts in the leaves They are most conspicuous towards the outside of the bud that is, the under surface of the mature leaf (x 30)
- 2 Longitudinal section of a leaf bud of *T. conferta* showing course taken by the oil ducts Towards the right-hand side are several stem ducts which are continuous with the leaf ducts seen further to the left. (x 16)
- 3 More highly magnified longitudinal leaf bud section than the preceding figure, showing portion of a leaf near the midrib The ducts are cut somewhat obliquely, but show definite evidence of branching, the almost vertical branch representing a canal accompanying a lateral vein To the left of this is portion of another lateral vein cut clear of the ducts (x 65)
- 4 Transverse section of a young leaf of *T. conferta* parallel to the midrib, showing a lateral vein with its accompanying ducts (d) which are just outside the bicollateral vascular tissue Four oil glands are present in the spongy mesophyll (x 50)
- 5 Transverse section of a young shoot of *Tristania conferta* passing through several outer rows of kataphylls or bud-scales The innermost group are the young foliage leaves surrounded by numerous hairs The cavities seen in the kataphylls are not oil glands but secretory passages, showing their enormous development in these scales (x 15)
- 6 Longitudinal section of a young shoot of *T. conferta* passing through a kataphyll parallel to the surface, and showing the extensive ramification of the oil ducts On either side are portions of the bud scales cut longitudinally, but at right angles to the surface (x 20)

Plate xlix

- 7 Transverse section of the midrib of a mature leaf of *T. conferta* showing the two almost parallel zones of bicollateral bundles, between which five ducts are to be seen, the greatest development occurs, however, in the loose parenchymatous tissue just below the lower vascular area Oil glands are to be found near the epidermis (x 30)
- 8 Transverse section of the midrib of a mature leaf of *Syncarpia laurifolia*. As in *T. conferta* the bicollateral vascular bundles are in two rows, and the greatest development of ducts occurs between them, and also towards the abaxial side. Only one duct is seen in the upper portion of the midrib. (x 30)
- 9 Transverse section of the petiole of a leaf of *S. laurifolia* near the lamina. Although ducts are present in conjunction with the larger group of vascular bundles, none are found near the two smaller ones, which correspond to the marginal veins (x 25)
- 10 Transverse section of a young stem of *Tristania conferta* showing the enormous duct development both in the pith and cortex. Just below the epidermis are numerous oil glands, but these are few in comparison with the large number of ducts (x 32)

Plate 1

11 Transverse section of the inner portion of an older stem of *T. conferta*. It is a characteristic feature that the medullary ducts are always close to the internal phloem (x 23)

12 Longitudinal section of a young stem of *T. conferta* passing through the cortex and outer portion of the phloem. Near either edge are the somewhat elongated oil glands. Nearer the centre are two cortical oil ducts, cut slightly obliquely (x 11)

13 Transverse section of the outer portion of a 64 mm stem of *S. laurifolia* showing the numerous oil ducts which occur in the secondary phloem. They are solitary and very evenly arranged. At the top edge is portion of one of the absciss phelloids which are developed successively at different depths in the phloem (x 19)

14. Transverse section of the inner bark of a mature tree of *S. laurifolia*. The ducts and bast fibre zones are evenly distributed. In the outer portion of the bark an enormous increase in size of the thin walled cells occurs, principally in a radial direction (x 23)

PRELIMINARY NOTE ON THE EMBRYO SAC OF *STYPHELIA*
LONGIFOLIA (R Br).

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(Twelve Text-figures)

(From the Botany Department of the University of Sydney)

[Read 28th November, 1923]

Introduction

The arranging of plants under a system which shows their natural affinities (genetic relationships) is still far from complete, and must remain so, though in a steadily decreasing degree, until the life-histories of the various species are known.

Comparatively little is known regarding the life-histories of the members of Natural Orders which dominate the Australian Flora, and of this fact the Epacridaceae form a well known example.

At present this family is associated with the Ericaceae, Clethraceae, Pircaceae, Lennoaceae and Diapensiaceae to form a cohort or Alliance—the Ericales (Engler and Prantl). Such a grouping, however correct it may eventually prove to be, is based on the general characters of the flower and fruit—superficial characters only.

The cohort referred to is regarded as the most primitive of the eight cohorts comprising the Sympetalae, and the possibility of finding genetic connections with the Archichlamydeae was an especial stimulus to investigation in this region.

Now, the Epacridaceae present certain peculiar features such as (a) a single whorl of stamens, (b) an anther composed of two microsporangia, (c) a longitudinal dehiscence of the anther. These features, *inter alia*, seems to demand investigation, and the ultimate aim of the writer is to make a morphological study of this Order, and then a comparison with the other Families of the Cohort.

The Epacridaceae

Engler and Prantl (1899) give 21 genera and 350 species, their geographical distribution being largely confined to Australia and Tasmania. In Australia they correspond to the Ericaceae of other continents, hence the name Australian Heath applied to the various species of *Epacris*. The Family however extends to South America, India, Hawaii and New Zealand.

Some 24 genera are native to Australia (Bentham, 1869) and of these the following occur in New South Wales —

(a) *Stypheha*, *Astroloma*, *Melchrus*, *Lissanthe*, *Monotoca*, *Leucopogon*, *Acrotriche*, *Brachyloma*, and *Trochocarpa*, which are characterised by a fruit indehiscent, usually succulent, seeds few or solitary; and

(b) *Woollea* (*Lysinema*), *Epacris*, *Sprengelia* and *Dracophyllum* with a dry loculicidally dehiscent fruit containing numerous small seeds

The first named genus has been selected for this investigation, primarily because the seeds are relatively large, and occur singly in each of the five loculi of the fruit, which is a drupe

Genus *Stypheha*

This genus is found only in Australia and comprises eleven species. All the New South Wales species—six in number—are to be found in the neighbourhood of Sydney, and for this investigation *Stypheha longifolia* forms the material.

Stypheha longifolia is an erect shrub about three feet high with narrow lanceolate leaves 1 to 2½ inches long, and tapering to a sharp point. The sepals are acute, while the tubular corolla is distinctly five-lobed and of a yellowish-green



- Text-fig. 1. A longitudinal section through an ovary cavity with the anatropous ovule cut in median longitudinal section. The angle massive integument (int) enclosing the nucellus (nuc) is shown, also micropyle (mic) and conducting tissue of chalaza (c.t.). (x 75)
- Text-fig. 2. Longitudinal section through an ovary cavity showing a very young ovule cut in median longitudinal section. The single integument (int) partially encloses the nucellus (nuc). The anatropous character of the ovule is indicated. The innermost layer of cells of the ovary wall (w) is shown. (x 125).
- Text-fig. 3. Median longitudinal section of an ovule slightly older than that in Text-fig. 2: the megaspore mother cell (meg. m.c.) is shown. (x 125).

colour. The flower is about one inch in length. The lobes are characteristically revolute, and a bunch of hairs is situated on each segment about half-way down the tube. The stamens are fused to the corolla tube, five in number, and alternate with the petal lobes, while the anthers, freely exposed, are versatile and introrse.

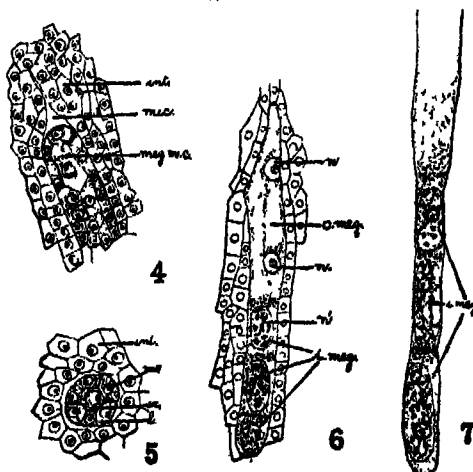
The supracarpous syncarpous ovary has five loculi, each bearing a single anatropous ovule (see Text-fig. 1). The fruit is a drupe, and succulent.

During his investigation of this species (*S. longifolia*) the writer found certain features in the megasporogenesis and development of the embryo sac that seemed more or less unique, and it is with these that the present short account deals.

The flower buds arise singly in the axils of the leaves of a shoot, each flower being enclosed by a number of sheathing bracts.

In Text-figs 2 and 3 is shown a single chamber of the ovary, and in it a young ovule is depicted. Even at this early stage the anatropous nature of the ovule is evinced. The nucellus is almost naked, but the single massive integument is clearly seen. The nucellus itself is of a very advanced type, consisting as it does of a single axial row of cells enclosed by tissue one cell thick. This is shown in Text-figs 2-5, where the nucellus is three cells in breadth.

The distal cell of the axial row is large relative to the others, and has a nucleus in proportion (Text-fig 4). This cell is interpreted as the megaspore mother cell which continues to enlarge.



- Text fig 4 Median longitudinal section of nucellus (nuc) slightly older than that in Text-fig 3, (meg mc) megaspore mother cell (mic) micropyle, (int) integument (x 195)
- Text-fig 5 Transverse section cut near apex of a young ovule, the nucellus (nuc) consisting of an axial row (ax) enclosed by a single layer of cells (l) is indicated (int) integument (x 195)
- Text-fig 6 Longitudinal section of a nucellus showing the outermost megaspore (o meg) beginning to develop, two nuclei (n) being shown. Three other megaspores (i meg) each with a large nucleus (n) are apparent (x 135)
- Text-fig 7 Longitudinal section as in Text-fig 6 showing a later stage in development. The non-functional megaspores (i meg) have increased in size, and show no sign of disintegration (x 135)

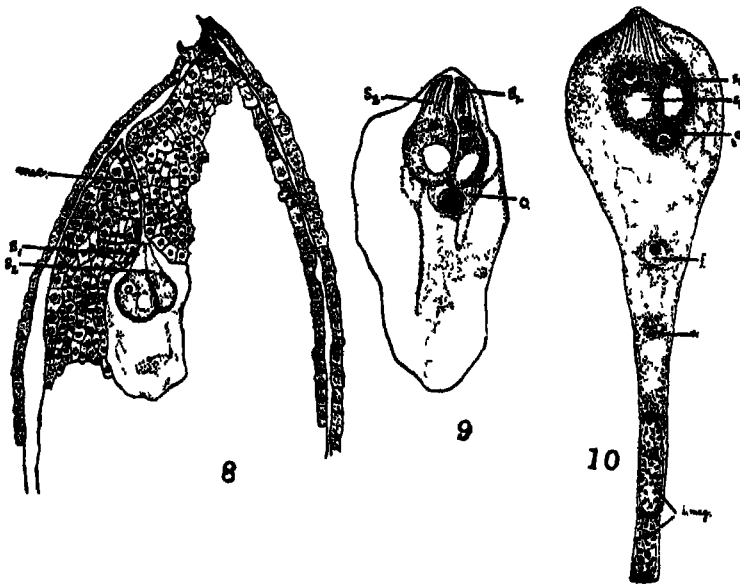
No parietal cell formation occurs. On division the megaspore mother cell produces a row of four megaspores, this fact and two nuclei resulting from division of the nucleus of the distal megaspore are illustrated in Text-fig. 6.

The growth of the ovary cavity is rapid, and easily permits of free development of the ovule (Text-figs. 1, 2, and 3).

Thus, as far as the history of the megasporogenesis is concerned, it has been

in conformity with that characteristic of the Higher Sympetalae. From this point, however, the development exhibits certain characteristics of its own. The megaspores continue to enlarge, but the functional megaspore is the micropylar one, and not the chalazal one, as is normally the case. This fact is indicated in Text-figs 6, 7, and 10.

This occasional functioning of the distal (micropylar) megaspore in the Sympetalae has already been reported as far back as 1888 by Oliver. Other investigators, Fry (1902), Vesque (1878-9), Lloyd (1902) and Guignard (1882), report cases in which megaspores other than the antipodal one may occasionally function, but it should be noted that the case reported by Oliver is the only one amongst the Sympetalae in which it has been clearly proved that the micropylar megaspore is the functional one, and even in this genus, *Trapella*, the cell adjacent to the distal one may on occasion be the one which develops to form the female gametophyte.



Text-fig 8 Longitudinal section of ovule showing two pyriform synergids in the embryo sac (s_1, s_2) synergids, (mic) micropyle (x 75)

Text-fig 9 Longitudinal section of embryo sac showing egg apparatus. The striated nature of the apices of the synergids is shown, (s_1, s_2) synergids, (o) egg (x 135)

Text-fig 10. Mature embryo sac and two of the three non-functional megaspores, (s_1, s_2) synergids, (o) egg, (f) fusion nucleus, (a) three antipodals, (1 meg) megaspores (x 135)

The development of the female gametophyte is as usual, the mature seven-celled condition being shown in Text-fig 10.

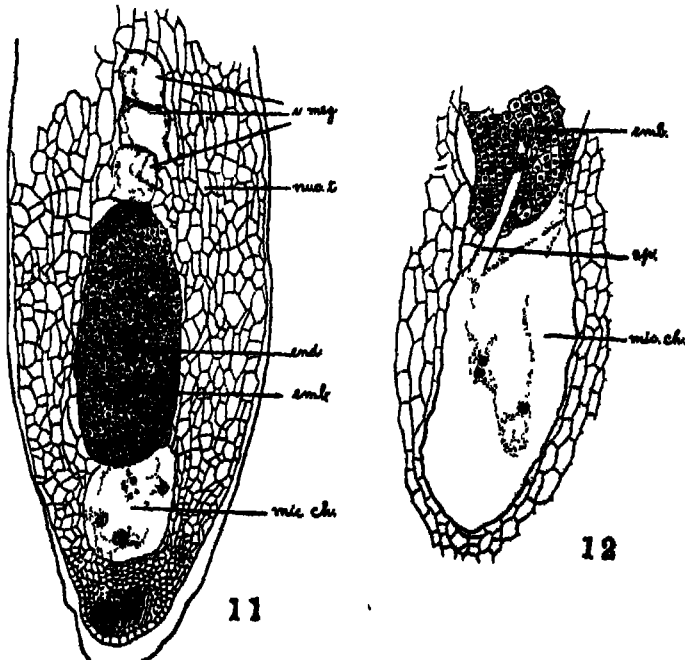
Although the nuclear divisions leading to the mature gametophyte are normal, the resulting cells have some very interesting characters. A singularly outstanding feature is the egg apparatus in which abnormally large synergids are developed (Text-figs 8, 9, and 10).

These synergids are pyriform, and the beak of each protrudes slightly into the micropyle. The narrow end has a very distinctly striated appearance and stains lightly, in striking contrast to the heavy staining characteristic of the body of the synergid. Each synergid has a large nucleus, and is vacuolate.

The polar nuclei fuse before fertilisation. The antipodal nuclei are small and disintegrate early. They represent the most insignificant feature of the gametophyte, and seem to serve no practical purpose.

Although the pollen tube was often seen in the micropyle, and even entering the embryo sac, still the male nuclei have not yet been identified with certainty.

The non-functional megaspores increase in size and persist until after fertilisation. Sections showing these megaspores without any evident sign of loss of vitality have been obtained at this stage. The innermost megaspore extends close to the conducting tissue of the chalaza and this fact, taken along with the distal



Text-fig 11. Longitudinal section of seed showing nucellar tissue (nuc t), endosperm (end), young embryo (emb.), and micropylar chamber (mic ch.). The former positions of the three non-functional megaspores are indicated (i. meg) (x 75)

Text-fig 12 Longitudinal section of seed at a stage slightly younger than that of Text-fig. 11. The micropylar chamber (mic ch) from which the long suspensor (sp) extends, is shown, (emb.) embryo. (x 125).

position of the functioning megaspore and the persistent character of the other two megaspores, is in the writer's opinion some ground for thinking that the non-functionary megaspores act as a via media for the passage of nutritive supplies from the chalaza to the developing embryo sac. Later the non-functional megaspores disintegrate, but their respective positions can be perceived even after the endosperm and embryo are well developed (Text-fig. 11).

Another noteworthy feature is the shape of the mature embryo sac (Text-figs. 11 and 12). At one end a large micropylar chamber is developed in a manner similar to that so often figured by Peltriset (1904) in his extensive investigations on the Ericaceae. This cavity is separated by a constriction from the main body of the sac. The function of this chamber is not apparent, because at maturity it only contains a few endosperm nuclei (Text-figs 11, 12). The embryo develops amid the endosperm in the middle of the sac, although the very long suspensor traverses the micropylar chamber and passes through the constriction (Text-fig 12).

It must be understood that this contribution to Epacrid life-history only presents one of many peculiar and interesting phases which have come to light as the result of the writer's investigations on *Styphelia* and other genera of the Epacridaceae.

At no distant date it is intended to submit for publication further results of such research.

Summary.

1. The ovary contains five loculi with one anatropous ovule in each chamber.
2. The ovule has a single massive integument, investing a nucellus consisting of an axial row of cells enclosed by a single layer of cells.
3. The hypodermal cell, at the apex of the axial row of the nucellus, functions as the megaspore mother cell.
4. No parietal tissue is produced.
5. The megaspore mother cell divides, and produces a linear tetrad of four megaspores.
6. The outermost megaspore functions—a somewhat unique character in the Sympetaleae—and develops the female gametophyte, which at maturity is of normal type.
7. An outstanding feature of the embryo sac is the extraordinarily large pyriform synergids, each with a distinctly striated apical region. The antipodal cells are insignificant and evanescent. The polar nuclei fuse prior to fertilisation.
8. The three innermost megaspores are non-functional, but enlarge and persist with unimpaired vitality until after fertilisation.
9. The endosperm develops rapidly. A micropylar chamber, suggesting a parallel to that described by Peltriset in his researches on the Ericaceae, is formed at the apical end of the embryo sac.
10. The long suspensor of the embryo traverses the micropylar chamber, passes through the constriction in the sac, and leads to the embryo which is embedded deep in the endosperm.

For helpful criticism and advice received during the course of these investigations the author desires to express sincere thanks to Professor A. A. Lawson, and to Dr. J. McLuckie.

Botany School, University of Sydney, 22nd June, 1923.

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NEW OR NOTEWORTHY PLANTS FROM THE
NATIONAL HERBARIUM, SYDNEY No 1

By EDWIN CHEEL, Senior Botanical Assistant

[Read 28th November, 1923]

Family GRAMINEAE.

POA BULBOSA L.

Orange, Young (J B Cleland) A European species of grass, naturalised in this State, previously only recorded from Cowra (These Proc, xxxxi, 1912, 654).

Family ORCHIDACEAE

DIPODIUM HAMILTONIANUM

Bailey, These Proc, vi., 1881, 140 —*D punctatum* R Br var. *Hamiltonianum*,
Bailey, Queensland Fl, 1902, p. 1549

Bumbery, NSW (J B Cleland)

This species was originally described by Bailey from specimens collected at Stradbroke and Peel Islands, near Moreton Bay, by Mr J Hamilton. What appears to be the same species is figured in Fitzgerald's "Australian Orchids" (1, 1882, 60). Mr. Fitzgerald says: "The light greenish form (fig B) is from specimens kindly sent to me from Guntawang, near Mudgee by my friend A. G. Hamilton. It may possibly be *D squamatum*, referred to (in a note) by Bentham in the Flora Australiensis, as from New Caledonia, and differing from *D. punctatum* 'chiefly in the more closely imbricate, appressed, and acute scales, at the base of the stem,' but I have never seen a specimen of the New Caledonian plant." Mr. A. G. Hamilton's specimens are not represented in the National Herbarium collection, but from the figure in Fitzgerald's work, it seems to me to be almost identical with the specimens collected by Dr. Cleland. The chief difference between this and the normal form of *D. punctatum* is in the decided greenish-yellow colour, and the prominent scales of *D. Hamiltoniana*, which are not apparent in any of the numerous specimens of *D. punctatum*. The figure in Fitzgerald's work is rather more green than the specimens collected by Dr. Cleland, but I find that the greenish colour gets more intense with age. I have compared the specimens with *D. squamatum* R.Br. from New Caledonia Plantae Schlechterianae (No. 18725) in the National Herbarium collection, and find that the basal-scales are larger and more acuminate than those of *D. Hamiltonianum*, and distinctly 5- to 7-nerved, or more.

Family PROTEACEAE.

ISOPOGON ANEMONIFOLIUS Knight, var. GERATOPHYLLOIDES, n. var

A low spreading harsh shrub, rarely more than 2 feet high, the young branches minutely scabrous or occasionally hairy. Flowers and fruiting very similar to *I. anemonifolius*.

This plant somewhat resembles the South Australian species *Isopogon ceratophyllus* R Br and is probably included in Moore and Betches's Handbook (p. 230) under that name, but it differs from that species in the broader and much less pungent pointed leaf-segments. It appears to be quite different in its habit from *I. anemonifolius* and may be worthy of specific rank but, as there are so many intermediate forms, it is proposed for the present to regard it as a variety.

The following is a list of localities as represented in the National Herbarium—Warialda (NW Garrard, October, 1904), Parishes of Vicars and Oregon Co Barnett, Zaminaba Creek, Pillaga Scrub, and Bumbury. The Bumbury specimens are more hirsute than the others and may be considered a variety if eventually it is considered wise to raise the Warialda specimen to specific rank.

ISOPOGON ANEMONIFOLIUS Knight, var. TENUIFOLIUS

This variety is recorded from Twofold Bay in Bentham's Fl. Aust. but is not mentioned in Moore and Betches's Handbook. There are specimens in the National Herbarium, which clearly belong to this variety, from the following localities—Ruiber's Creek, near Kydra Trig Station 3700 feet, Conglomerate formation, Great Dividing Range, Kybean River, R. H. Cambage (No 2008), Mongariowe near Braidwood, R. H. Cambage (No 2051), Charlie's Forest, Braidwood. It is described by both Mr Cambage and Mr Boorman as "a low prostrate plant."

ISOPOGON ANEMONIFOLIUS Knight, forma SIMPLICIFOLIA

Mount Victoria and Hornsby.

Similar to the normal form in the floral characters, but many of the leaves are quite simple, and the above name will distinguish this form from the normal species.

Family LEGUMINOSAE

GASTROLOBIMUM BOORMANI Maiden and Betches.

The type specimens of this species were collected at Jilby Jilby Range near Wyong. It was afterwards recorded for Milton (*vide* These Proc., xxiv., 1899, 143, and xxvii., 1903, 906). Since these records were made we have received specimens from the following localities—Styx near Hill Grove, Coolpa Mountains and Ulong, Eastern Dorrigo.

DILLWYNIA PHYLLOIDES A. Cunn.

Hill Top (E Cheel, October, 1915). This is an additional locality, giving the species a much wider range, and bringing it much further south than those records given in These Proc., xxxix., 1914, 471.

DILLWYNIA SPINESCENS, n.sp.

This species has been under observation since August, 1898, and was referred to in These Proc., xxxix., 1914, 471. It is well worthy of specific rank and may be described as follows—

Fruticulus decumbens intricato-ramosus 3-9 dm. altus, ramulis glabris spinescentibus, foliis glabris, brevissime petiolatis, obtusis vel fere acutis, line-

aribus vel anguste-oblongis, 4-6 mm longis; floribus in axillis solitarius, breviter pedunculatus, tubo calycis glabro, lobis superioribus fere ad apicem conjunctis, quoniam inferiores longioribus; carina rubida; legumine hirsuto

Specimens have been compared with some in the Melbourne Herbarium called, by Baron von Mueller, *D floribunda* var *spinescens* and admitted in Maiden and Betche's Census of New South Wales Plants (1916, 104) under Mueller's name. The floral character and the general habit, however, are so clearly distinct from those of *D floribunda* that it is thought advisable to raise it to specific rank.

A low, somewhat straggling shrub, varying in height from 1 to rarely more than 3 feet, the branches more or less tangled, quite glabrous, and the branchlets terminating in slender attenuated spines. Leaves 2 to 3 lines long, glabrous, very shortly petiolate, obtuse or scarcely pointed, linear or narrow oblong, not twisted as in *D ericifolia* or *D floribunda*, the upper surface showing a well defined channel. Flowers singly in the axils of the leaves, shortly pedunculate, usually numerous along the spinescent branchlets. Calyx tube quite glabrous, the upper lobes united nearly to the apex and larger than the three lower ones. Corolla very similar in colour to *D ericifolia*, except the keel, which is of a deeper red, and the slightly longer claw of the standard. Pod hirsute.

Its characters are intermediate between those of *D ericifolia* and *D floribunda*, but it may be distinguished chiefly by the following characters:—Flowers always singly in the axils of the leaves, whereas in *D floribunda* they are mostly in pairs and in *D ericifolia* they are in terminal racemes or clusters, leaves quite smooth with a straight comparatively broad channel on the upper surface and never twisted, whereas in *D floribunda* and *D ericifolia* the leaves are nearly always twisted, with a slight channel on the upper surface and more or less glandular scabrous. The numerous branchlets of the new species terminate in a distinct spine which, so far as I have seen, never occurs in any of the other species belonging to the genus.

Bishopecourt, Randwick (E Cheel, August, 1898), Hill Top, Bowral to Bulloo, Berrima, Badgery's Crossing to Nowra, Fitzroy Falls, Moss Vale, Burragorang, West Dapto and Cronulla, Nowra.

SWAINSONA LUTEOLA F v M

This species has previously only been recorded for Queensland. Specimens have frequently been forwarded to the National Herbarium for determination, the correspondents invariably stating that it is poisonous to stock.

It has evidently been overlooked as a New South Wales species, owing to the characters given in Bentham's key to the species disagreeing with the description as follows:—"Style slender, not hooked. . . ." (in sectional key). In the description he states that the "style is short, inflexed almost involute at the extremity." Specimens in the National Herbarium are from the following localities: Dubbo, Narromine, Gooraweenah, Tamworth District, Nyngan, Warialda, Gunndah, Breeza, Bobadah, Brewarrina, Burren Junction, Narrabri, Cobar, Coonamble, Boggabri (R. H. Cambage, No. 3610), Condobolin and Tibbooburra.

PULLENBURA SCHIMULA Sieb.

The original description of this species is published by De Candolle (Prod., ii., 1825, 112) who quotes a figure given by Reichenbach (Icon. Exot., t. 196). It is also recorded by Sprengel (Syst. Cur. Post., 1827, 173) who erroneously spells the specific name "*schmata*." Then we have it recorded by Bentham (Fl. Austr., ii.) who gives Brisbane River, Queensland as a doubtful locality, and

Port Jackson to the Blue Mountains as New South Wales localities. It is interesting to note that Benth (l.c.) who quotes Sieber's No. 384 type specimen states that "Sieber's specimens have the upper leaves more hairy than R. Cunningham's (also collected on the Blue Mountains), whilst in the latter the calyx is villous, which in Sieber's is glabrous" In "A Revision of the Genus *Pultenaea*," Williamson points out (Proc Roy Soc. Vict, xxxiii, 1920, 147) that "The National Herbarium (Melbourne) contains a single specimen of the type referred to in Benth, Fl Austr., p 127 'Sieb n 184, New Holland' It does not appear to have been gathered since" Mr. Williamson has very kindly forwarded some bracts, bracteoles, calyces and ovaries dissected from the type specimens, which have been carefully compared with the large series of specimens in the National Herbarium, Sydney and, as a result, I have been able to add the following specific localities—King's Tableland, Blue Mountains (W. Forsyth, November, 1898), Mount Victoria (W. F. Blakely, October, 1910).

PULTENAEA DIVARICATA Williamson

Proc Roy Soc Vict, xxxiii, 1920 (1921), 147

As pointed out by Williamson (l.c.) this species has passed as *P. echinula* Sieber, but differs from that species in having hairy bracteoles, silky-hairy ovary and the leaves shorter and more glabrous. The stipules are not so persistent as in *P. echinula*.

It was originally collected by A. Cunningham on the Blue Mountains and referred to by Benth (Fl Austr., ii), who pointed out that "the calyx is villous, which in Sieber's (specimen of *P. echinula*) is glabrous" Benth also mentioned that "Sieber's specimens have the upper leaves more hairy than R. Cunningham's" The only records given by Williamson for this species are specimens from Wentworth Falls, Blue Mountains, collected by J. H. Maiden and J. H. Campbell. In the National Herbarium, Sydney, there are, in addition to the above, specimens as follows—Hill Top, Main Southern Lane (E. Cheel), Wingello (J. L. Boorman), Lawson (A. A. Hamilton), King's Tableland (W. Forsyth), Leura (A. A. Hamilton), Katoomba (W. F. Blakely), Blackheath (R. H. Cambage, No 1204), Mount Wilson (J. H. Maiden).

Family EUPHORBIACEAE

CROTON MAIDENI R. T. Baker

In Journ Roy Soc N S W, xlviii, 1914, 444, this species is recorded for the highest point between Angledool and Queensland border, known as "Guthrie's Mountain" (now Read's Mine), about twenty feet above the black soil plains.

In the National Herbarium, there are specimens from additional localities as follow—Mount Mitchell near Warialda (Forest Guard De Benzeville) called "Wild Sage", Narrabri District (Forester Swain), Gunnedah (J. L. Boorman).

Family DILLENIACEAE.

HISBERTIA MONOGYNA R.Br.

DC, Regni Veg Syst Nat, 1818, 429—*H. dilatata* A. Cunn, Herb., *H. diffusa* var. *dilatata* Benth, B. Fl, i, 37.—*H. fasciculata* var. *clavata* Maiden and Betcher, These Proc., xxxiii, 1908, 304.

The habitat given in De Candolle's work is Mountains (Caley) and Port Jackson (R. Brown). Benth, in addition to Port Jackson, says;—and southward to Yowaka River (F. v. Mueller).

In the National Herbarium we have a fine series of specimens from Upper Hunter River (Stephenson, December, 1886), Balmoral (J. Bingham), George's River district (Rev T. V. Alkin), W. Dapto (R. H. Cambage), Cataract Dam (J. H. Maiden), Baerami Creek, Denman (R. H. Cambage, No. 2682), Hill Top (E. Cheel), and Coonabarabran (J. L. Boorman)

The upright habit and differently shaped leaves, as well as the fewer carpels and wide distribution, clearly show that it is distinct from both *H. diffusa* and *H. fasciculata*

Family SAPINDACEAE

DIPLOGLOTTIS CAMPBELLI, n sp

Arbor ad 60-80 ped alta, ramis junioribus plus minus angularibus pilosus; folia alternatis, foliolo 2-3 jugis, lamina glabris, nervus et rhacis pilosus. Inflorescentiae ramosus confertus paniculatus dispositi axillaris terminalibus. Calycis 5-partibus, pilosus, petala sub-rotundatus, basi brevi unguiculatus cupulatus, bi-glandulosus, sessilibus rugosus-dorso cristatus, stamina octarinus unequalibus, filamentis glabro. Ovarium pilosus, 3-locularis, stylus integro apice vix curvus; semina globoso solitarius

Large tree, 60 to 80 feet high, with a trunk varying from 2 to 3 feet in diameter

The young branches more or less angular, grooved, and the whole plant more or less hoary or pilose except the leaflets. Leaves abruptly pinnate, alternate, about 10 to 15 cm long, including the petiole, leaflets usually 2 to 3 pair, opposite or occasionally slightly alternate, shortly petiolate, glabrous above as well as on the underside, but the midnerve and petioles slightly pilose, obovate-oblong, to ovate-lanceolate, more or less acuminate but the extreme apex decidedly obtuse. Flowers more or less crowded in composite ramose panicles, terminal or in the axils of the upper leaves.

Sepals 5, ovate-lanceolate, sessile, imbricate, densely pilose on the outside and slightly so on the inside, 2 to 2 mm long, and about $1\frac{1}{2}$ mm. broad

Petals 4, shortly but distinctly clawed, cupulate, enclosing two sessile rugose yellowish-coloured glands at the top intermingled with a few fibrillose hairs

Stamens 8, unequal in length, filaments glabrous

Ovary pilose, 3-celled, 1-seeded. Style entire, slightly curved, the apex shortly hooked

Capsule glabrous, dehiscent, globose-3-gonal, with valvate cell $3\frac{1}{2}$ to $5\frac{1}{2}$ cm across and about $3\frac{1}{2}$ cm. thick, i.e. from base to apex, or from abortion only 2-lobed and then containing only 2 or one seed. Seeds globose or semi-globose through pressure in the capsule, varying in size from $2\frac{1}{2}$ to 4 cm diameter when fresh, enclosed by a comparatively smooth, blood-red coloured arillus, testa comparatively thick and hard, more or less rugose. This appears to be a very unique plant and is likely to be of economic importance, as it is a fairly large tree and may be a useful timber and, in addition, it bears fairly large fruits with seeds having a thick fleshy pulpy arillus of a fine acid flavour and which may be very useful for preserves or for jam.

At first sight it would appear that this species belonged to the genus *Ernoglobosum*, but as the fruits of our plant are distinctly dehiscent and those of *Ernoglobosum* are indehiscent it was necessary to investigate carefully the characters of other closely allied genera with a view of grouping it with those species having closer affinities. Although we have only one species of the "Native Tamarind" (*Diploglottis Cunninghamii*) and our plant at first sight did not appear to have

any resemblance to this species, it proves on investigation that the fruit is a locu-licidal capsule whose seeds are also globose in each cell and enveloped by a large fleshy aril. The figures of Baillon (Nat Hist Plants, 5, 1878, 416, figs 378-381 on pp 360-361) are not strictly correct, as has already been shown by Hooker f. (Bot Mag, tab 4470, and Bentham, Fl Australiensis, 1., p 454). The fruits of this latter species, together with the var *Muelleri* of Bailey (Q Fl., 1, 287, *Cupania diphylostegia* F.v.M., Fragm., v, 1865-1866, 145), are also said by Bailey to be edible and useful for jam making (see Bailey, Comprehensive Cat., p 112), but are much smaller and the arillus is of a yellowish colour and not blood-red, as in our new species. It was originally collected by M. Bauerlen, in February, 1892, at Tintenbar, when it was determined as *Amoora nitida*, a species belonging to the family Rutaceae. In January, 1904, Mr R. A. Campbell forwarded specimens from the Tweed River, which were provisionally determined as *Cupania*. In February, 1918, and again in March of the same year, some leaves and ripe fruits, forwarded by Mr Campbell, enabled me to place this in the genus *Diploglottis*. The specific name *Campbelli* is proposed in honour of Mr R. A. Campbell who has interested himself in this and many other plants of the Tweed River District.

The following particulars concerning this species were communicated to Mr J. H. Maiden by Mr C. T. White, Government Botanist, Queensland.

"I was extremely interested in the plant of which you sent specimens and drawings with your letter of the 4th inst, Mo. 1009/18.

"The following is an account of my acquaintance with this tree. In February, 1913, Miss M. Chisholm brought into my grandfather (Mr F. M. Bailey) a plant for naming, she said it was growing in their garden at Spring Hill. He could not place it and we spent a lot of time looking up foreign Sapindaceae. They were fruiting specimens only, and we asked for flowers, but never received any, and as we thought the tree an exotic did not bother much about it.

"In February, 1916, when my uncle (J. F. Bailey) was Government Botanist, specimens of the same tree were brought in for identification by Mr. W. Harding from a tree growing in the garden of Mr McGrath, Toowong. We went through the same performance of looking up exotic Sapindaceae, the seeds of which are covered by an acid, edible arillus, and could not place it.

"A couple of months afterwards, when looking through some bundles of undetermined specimens collected on Mudgeeraba Creek in June, 1914, when I visited that locality with my friend, Mr. J. E. Young, I came across some leaves marked "Native Tamarind," and I saw that they belonged apparently to the same tree as that we had received for identification from two Brisbane gardens. As some years ago Mr Young was living at Mudgeeraba, I spoke to him about it, and he informed me that the tree was common along Tallebudgera and Mudgeeraba Creeks, and was commonly known thereabouts as "Native Tamarind." I told him why I was interested in the tree, and he said he would write to several people he knew thereabouts and ask them if they knew of it, and if it was still common. He did, and they all wrote back to say that they knew the tree well, but that naturally now the scrubs were down there were not so many trees of it to be found wild.

"Last December (1917) Mr. Young and I went up the Macpherson Range via Tallebudgera. We kept a good look out for this tree and saw several very fine specimens along Upper Tallebudgera Creek. It was bearing immature fruit, but I gathered a quantity of it, but could not get flowers, except a few decayed fragments.

"I meant to keep these trees under notice next season and get flowers

"It must be new I think, and yet it seems so strange that such a notable tree, and one well known to the settlers, should have escaped the notice of botanical collectors.

"I may state that in the garden trees the arillus was yellow, not red as in the wild plant, but I think the colour of the arillus in these sapindaceous plants often varies. It is certainly a handsome tree, makes a dense shade, is very heavily foliaged with dark glossy green leaves and is an ornament to any garden "

Family UMBELLIFERAE.

ERYNGIUM DECAISNEANUM Urban.

An introduced weed, naturalised in the Kensington and Botany swamps
The specimens were kindly identified by the Director, Royal Botanic Gardens, Kew.

Family EPACRIDACEAE

MELICHRUS ADPRESSUS A Cunn. (*Styphelia Cunninghami* F v M)

Wardell (W Bauerlen), Eungella, Tweed River, Tweed Heads (W Forsyth), Broadwater (E. Cheel), Warrumbungle Ranges (W Forsyth)

MELICHRUS ERUBESCENS (A Cunn) DC

Gilgandra (R H. Cambage, No 1092), Harvey Ranges (J H. Maiden), Minore (J L Boorman), Warrumbungle Ranges (W. Forsyth), Gulgong (J H Maiden and J L Boorman), Bowan Park near Cudal (W F Blakely), Bogan Gate (R. H Cambage, No. 1957), Baerami (R H Cambage, No 2865), Coonabarabran (E Betcher), Bumbery (J B Cleland), Peak Hill Road near Dubbo (J B. Cleland), on Stony Hill near Molong (J B Cleland).

These two species are included by Bentham as synonyms of *M urceolatus* R.Br, but the characters of the foliage and flowers, and the habit and distribution of the plants are so very distinct, that it seems advisable to regard them as distinct species

Family LABIATAE.

HEMIGENIA CUNEIFOLIA Benth.

The original specimens of this species were collected on the George's River by Woolls and on the Macleay River by Beckler. These were referred by F von Mueller (*Fragm.*, vi., 110) to *Westringia glabra* R.Br, but, as pointed out by Bentham (*B Fl*, v, 118), are different in the leaves and very different in corolla and anthers. As regards the George's River locality, quoted by Bentham and said to be "very rare," Mr J Staer, has re-discovered it in October, 1910, and additional specimens were also collected in the same neighbourhood by Mr. J. L. Boorman, in November of the same year as those collected by Mr. Staer, but more towards Glenfield.

In addition to the above localities, I have since found several plants of this species on sandstone slopes of a deep gorge at Hill Top in July, 1914, and again at another spot in February, 1916. The latter specimens were in flower and are from plants from two to three feet high. The corolla when fresh was of a bright blue colour, with from 18 to 21 deeper blue coloured lines in the paler blue corolla tube, and two orange-coloured spots on the lower lip on which the anthers rest.

There is a superficial resemblance between *Hemigenia cuneifolia* and *Westringia glabra*, but the branches, pedicels and calyx-tube of the latter species are

distinctly more or less pubescent, whilst those of the former are perfectly glabrous. The lower lip of the corolla of *H. cuneifolia*, is also convex, whilst that of *W. glabra* is broad and flat.

Family COMPOSITAE

OLEARIA ASTEROTRICHA F v M var. *PARVIFOLIA* Benth

Braemar (J. H. Maiden), Bowral (W. Greenwood), Hill Top (E. Cheel), Marrangaroo (E. C. Chisholm and W. F. Blakely, May, 1922)

The habitat for this variety is given by Benth as Bargo Brush (Back-house), also near Portland, Victoria. It seems sufficiently distinct from *O. asterotricha* to be regarded as a species, but further research is necessary before raising it to specific rank.

ABSTRACT OF PROCEEDINGS

ORDINARY MONTHLY MEETING

28th MARCH, 1923

Mr A F Basset Hull, President, in the Chair

PAPERS READ

- 1 The High Temperature Organism of Fermenting Tan-bark Part II
By R Greig-Smith, D Sc, Macleay Bacteriologist to the Society
- 2 Studies in Symbiosis No 3 A Contribution to the Morphology and
Physiology of the Root-nodules of *Podocarpus spinulosa* and *P elata* By J
McLuckie, M A, D Sc
- 3 New Termites from Central and South-East Australia By G F Hill,
F E S
- 4 Studies in Australian Entomology No xviii By T G Sloan

Mr E Cheel submitted the following notes as a result of comparison of the variants (about 16 in number) of Sturt's Desert Pea, *Chanthus Dampieri* A Cunn brought together under cultivation by Dr O M Moulden, at Broken Hill, with those already figured in various publications - The normal form is well depicted in Paxton's "Flower Garden," 1, 1853, p 49, tab 10, Bot Mag, 1858, t 5051, Lemaire's "L'Illustration Horticole," 1858, tab 173, and "The Garden," July 23rd, 1881, p 86 In addition to the normal species there is a beautiful coloured illustration of *C Dampieri* var *flores albo rubro-marginato*, in Lemaire's "L'Illustration," 1865, Pl 456 It is interesting to note that so far, none of those collected or cultivated by Dr Moulden exactly matches the latter variety, so that it would appear that fifteen of Dr Moulden's series are distinct There is another variety recorded in "The Garden," March 29th, 1890, p 298, under the name *C Dampieri* var *marginatus*, but the plate (746) is missing from the above work in the National Herbarium Library

The Donations and Exchanges received since the previous Monthly Meeting (20th November, 1922), amounting to 29 Vols, 261 Parts or Nos, 16 Bulletins, 15 Reports and 2 Pamphlets, etc, received from 108 Societies and Institutions and 3 private donors were laid upon the table

ORDINARY MONTHLY MEETING

18th APRIL, 1923

Mr A F Basset Hull, President, in the Chair

Messrs Walter Henry Bone, 15 Bond Street, Sydney, Arthur Hill Kelvin Petrie, Wonga Street, Strathfield, and Albert Edward John Thackway, "Wyoming," Albion Road, Strathfield, were elected Ordinary Members of the Society

The President announced that the Council had elected Mr A G Hamilton, Professor H G Chapman, M.D. B.S., Messrs J J Fletcher, M.A., B.Sc., and G A Waterhouse, B.Sc., B.E., F.E.S., to be Vice-Presidents, and Mr J H Campbell, M.B.E., to be Honorary Treasurer for the current session, 1923-24.

The President offered the congratulations of members to Sir Douglas Mawson (in absentia) on his selection as a Fellow of the Royal Society of London.

The President announced that the Council has resolved to invite members to express their opinions as to the hour at which business is commenced at the Ordinary monthly meetings.

PAPERS READ

- 1 The *Loranthaceae* of Australia Part iv By W F Blakely
- 2 Some notes on the Permo-Carboniferous and overlying Systems in Central Queensland By H I Jensen, D.Sc.
- 3 Studies in life-histories of Australian Diptera Bruchycera. 1 Stratiomyidae No 4 The respiratory system in larva, pupa and imago of *Metopoma rubriceps* Macquart By Vera Irwin-Smith, B.Sc., F.L.S., Linnæan Macleay Fellow of the Society in Zoology

NOTES AND EXHIBITS

Mr W F Blakely exhibited from the National Herbarium the following new weeds for the State (1) *Solanum elaeagnifolium* Cav, "Silver-leaved Nightshade," Warre Warral (L J A Fitzpatrick), Koorawatha (M J Dixon) It is a Chilian plant which propagates by seeds and rootstocks. It is very closely allied to the native species *S. coactiliferum* J M Black. (2) *Carthamus dentatus* Vahl, "Mediterranean Thistle" Murrumburrah (J Jamieson), Boorowa (T G Wernham) A native of the Mediterranean, it closely resembles *C. lanatus*, from which it can be distinguished by the glandular-pubescent vestiture, more venulose leaves, pink or purple flowers, longer pappus, and larger achenes. (3) *Cirsium arvense* (L) Scop, "Canada Thistle" Jindabyne, Berridale District (D J O'Rourke) In the United States it is a serious pest in agriculture, and is looked upon as one of the worst weeds, and the most difficult to eradicate.

Miss Irwin Smith exhibited the following species of Diptera, which she has bred in captivity, or reared from larvae or pupae—Stratiomyidae: *Metopoma rubriceps* Macq, *Neoeuxareta spinigera*, *Odontomyia laterimaculata*. Tabanidae: *Panqomus* (Subgen *Erephopsis*) *vicina* Taylor, *Tabanus* (*Theroplectes*) sp. Mydidae: *Trichonotus gracilis* Macq (Syn *Cephalocera gracilis*). Bombyliidae: *Docidomyia puellaris*, *Bombylius* ? *consobrinus*, *Aguraemoeba incisa* Macq, *Anthrax alternans* Macq, *A* sp nov ? (a), *A* sp (b), *A* sp (c). Therevidae: *Anabarrhynchus rufipes* Macq, *A* near *latifrons* Macq, *A* sp (a), *A* sp (b), *A* sp (c), *A* sp (d), *A* sp (e), *Lonchorhynchus* sp (a), *L* sp (b), *Agapophylus pyrrhotelus* Walk. *Phycus* ? *dioctriaformis* Schin, *P* sp (a), *P* sp (b), *Paranilocephala* sp (a), *P* sp (b), *P* sp (c), and 18 specimens comprising at least four different species of Therevidae, genera undetermined. Asilidae: *Neoaratus hercules* Wied, *Stenopogon elongatus*, *Rhabdotoxotamus vittipes* Macq, *R* ? *brunneus* White, *Neotamus fulvopubescent* Macq, *N* *neoclaripes* Hardy, *N* *grandis* Hardy, *N* near *gibbonsi* Ric, and one specimen of an undetermined species. Empididae: *Tenontomyia gracilipes* White. Muscidae: *Muscina stabulans* Flin, *Lucilia sericata* Meig and six species, genera undetermined. Sarcophagidae: One undetermined species. Tachinidae: Two undetermined species. Dexidae: *Rhychodexia rubricarinata* Macq and one species of an undetermined genus. Anthomyiidae: One undetermined species. Mycetophilidae: Six specimens of an undetermined species.

Tipulidae *Macromastix constricta*, *M. mastersi* Skuse, ? *Plusiomyia gracilis* Walk. and one undetermined species Bibionidae *Bibio imitator* Agromyzidae *Phytomyza* ? *affinis*

Mr M B Welch exhibited nails driven into the bark of a Queensland Kauri (*Agathis Palmerstoni*) on which increment measurements were being made. After two years the nails were forced out of the bark by the latter's abnormal development, and are embedded in a conical-shaped hard tissue. The outgrowth consists mainly of large stone cells, loose parenchyma containing many tannin sacs and a few bast fibres. There is a slight development of oleo-resin cavities.

The Donations and Exchanges received since the previous Monthly Meeting (28th March, 1923), amounting to 5 Vols, 64 Parts or Nos, 1 Bulletin, 1 Report and 2 Pamphlets, etc., received from 43 Societies and Institutions and 3 private donors were laid upon the table.

ORDINARY MONTHLY MEETING

30th May, 1923

Mr A F Basset Hull, President, in the Chair

Messrs Ernest Francis Hartley Brown, Burnie Street, Clovelly, and Archibald James Gray, 71 Pigott Street, Dulwich Hill were elected ordinary members of the Society.

A letter was read from Sir Douglas Mawson returning thanks for congratulations.

Mr J H Maiden forwarded a copy of a letter enquiring what botanists can attend the Imperial Botanical Conference to be held in London next year and asking for topics of special interest for discussion.

The hour at which the business is commenced at general meetings was discussed and it was resolved "that it be a recommendation to the Council that a postal vote be taken among metropolitan members of the Society as to the hour at which business shall commence at the general meetings, and that members be given an opportunity to vote for the hour of 7.30 or 8 o'clock."

The portions of the President's address dealing with Biological Survey of Australia and Breeding experiments with *Timphone* were discussed by Messrs Froggatt, Stead, Le Souef, Troughton, Nicholson and the President.

PAPERS READ

1. Revision of the genera *Ethon*, *Cisseis* and their Allies. By H. J. Carter, B.A., F.E.S.

2. A revision of the Australian Diptera belonging to the genus *Sarcophaga*. By Professor T. Harvey Johnston, M.A., D.Sc., and G. H. Hardy.

3. The life-history of *Microcachrys tetragona* (Hook.) By Professor A. A. Lawson, D.Sc.

4. Studies in Symbiosis. iv. The root-nodules of *Casuarina Cunninghamiana* and their physiological significance. By J. McLuckie, M.A., D.Sc.

NOTES AND EXHIBITS

Mr W. F. Blakely exhibited, from the National Herbarium, a specimen of *Xanthium spinosum* L., Bathurst Burr, from Wellington district showing hypertrophy of the fruits, and proliferation and hypertrophy of the spines. Some of the fruits are much inflated, and when opened they contained no seeds, while the

fruit spines are fully three times longer than the normal spines and many of them are quite straight. In some cases the stem spines have increased from three to nine, and are also much thicker than the normal stem-spines, exceeding the latter in length by 3.5 cm.

Mr E Cheel exhibited a fungus (*Ganoderma lucidus* var *japonicus*?), showing several peculiar outgrowths from the original sporophore which had been developed in an attempt to mature its hymenium. Somewhat similar specimens were recorded in These Proceedings, 1911, 504 and in the Roy Soc of NSW, Proceedings, 1917, 474. It would appear that in each case the fungus-growth was grown generally on *Casuarina* sp. in unnatural surroundings. He also exhibited specimens of *Monotoca ledifolia* A. Cunn., collected in a deep gully at Hill Top (Main Southern Lane), thus establishing another widely separated locality to those already recorded in These Proceedings (1902, 213).

Dr H G Chapman gave some account of the forms of carp obtained by crossing two fan-tailed gold carp. He also recorded the unusual flowering during March, April and May of various plants of genus *Rhododendron*. After the dry warm summer, plants which had flowered last November came again into full flower.

Mr W W Figgatt exhibited:—(1) A lace puff ball fungus (*Phallus indusatus*) from the Solomon Islands, (2) a series of the smaller cotton boll moths found in Australia. The small green cotton boll moth, *Earias huegelii* showing variation in colour, the Egyptian green boll moth *Earias insulana*, yellow spotted maize moth, *Cogogethes punctiferalis*, and the pink boll moth, *Platyedra gossypiella*, (3) the life-history of *Penthea pita*, a longicorn beetle doing a great deal of damage to the saltbush in the Coonamble district. The larvae bore down the main stem, and then down into the roots, (4) the large Lamellicorn beetle, *Oryctes barbarosa* and its larva. The larva and beetles were obtained in the rotten base of a tree trunk.

Mr A R McCulloch delivered a short lecture, illustrated with lantern slides, on "The Mud People of Papua."

The Donations and Exchanges received since the previous Monthly Meeting (18th April, 1923), amounting to 12 Vols., 207 Parts or Nos., 33 Bulletins, 6 Reports and 7 Pamphlets, etc., received from 67 Societies and Institutions and 5 private donors were laid upon the table.

ORDINARY MONTHLY MEETING

27th JUNE, 1923

Mr A F Basset Hull, President, in the Chair

Messrs Patrick Brough, M A., B Sc., B Ag Sc., "Kinross," Billyard Avenue, Wahroonga, and A A Lawson, 9 Wilnot Street, Sydney, were elected ordinary members of the Society.

The President called the attention of Zoologists to a letter from the Zoological Society of London stating that unless increased financial aid, in the form of subscriptions, etc., is forthcoming, the Zoological Record will not be published for years subsequent to 1921.

The President announced that the Council had decided to have, at the August meeting, a discussion on Mr Sloane's suggestion for the reservation of all areas in New South Wales above 4,000 feet in altitude.

The President also announced that the Council had decided to take a postal

vote of members in the metropolitan district with regard to the hour of meeting and that ballot papers will be issued early in July

PAPERS READ

- 1 Notes on Freshwater Algae By the late G I Playfair
- 2 Studies in the vegetation of arid and semi-arid New South Wales Part 1 The plant ecology of the Barrier District By Miss M I Collins, B Sc., Linnæan Macleay Fellow of the Society in Botany
- 3 A Monograph of the Freshwater Entomostraca of New South Wales Part III Ostracoda By Miss Marguerite Henry, B Sc., Linnæan Macleay Fellow of the Society in Zoology

NOTES AND EXHIBITS

Mr W F Blakely exhibited from the National Herbarium the following exotic plants which appear to be new for the State (1) *Heliotropium anchusaeifolium* Poir (Borraginaceae) from Whittingham, near Singleton (J H Maiden) It is a native of Central America and has been established in Queensland and South Australia for a number of years (2) *Hebenstreitia integrifolia* L This South African plant has established itself at Stockton and was first brought under notice by Professor J B Cleland in 1915, and again recently by Mr W M Steinbeck, who states that it grows freely on the foreshores at Stockton and is spreading back from the ballast tips Engler and Prantl (Pflanzenfamilien, iv, 3 B) place *Hebenstreitia* under Scrophulariaceae, but R A Rolfe who has monographed the genus (Thurston-Dyer, Flora Capensis, v, 95), retains it under Selaginaceae

Mr E Cheel exhibited specimens of two species of *Euphorbia*, collected at Lautoka, Fiji, in July, 1918, as follows — (1) *Euphorbia hirta* Linn. It is recorded by Seeman (Fl Vit, p 216) under the name *E pilulifera* L but as pointed out by N E Brown in Fl Trop Africa, vi, pt 1, 1913, p 497, the latter is identical with *E hypericifolia* L, and the plant that has passed under the name of *E pilulifera* is really *E hirta* L This correction has been adopted by Fawcett and Rendle (Flora of Jamaica, iv, 1920, 337) It is also naturalised in the Port Jackson District, Copmanhurst and extends to N Australia. (2) *Euphorbia prostrata* Ait Quite common at Natova and Lautoka This is a very common weed in the Tropics, very closely resembling *E Drummondii* Boiss, which, as also pointed out by Bentham (B Fl, vi, 49), closely resembles the European *E chamaesyce* L (spelt chamaesyce) S F Gray (Nat Ari Brit, 2 1821, 280) set up a genus *Chamaesyce* taking *E pepus* as the type and C F Millspaugh (Field Columb Mus. Bot II, 1900, 303 and 406), and W F Blakely (These Proc, 1922, p xxxi. and Agric Gaz N.S.W., 1923, 288), following Gray, have included *E thymifolia*, *E prostrata*, and *E Preslii*, under this genus and, in addition, there are upwards of 80 species, including several Australian species, which would have to be transferred, if *Chamaesyce* were regarded as a good genus

The exhibitor proposed to follow N E. Brown, Fawcett and Rendle, in retaining these species in the genus *Euphorbia*.

Dr A. B. Walkom exhibited specimens of *Osmundites* and a Tæmnopterid with very numerous short cross bars connecting the secondary veins The fossils were obtained from the Lower Mesozoic Rocks of Queensland

Papers in the Proceedings for 1923, Part 2, were discussed by Dr Walkom, Mr Froggatt and Dr Greig-Smith

The Donations and Exchanges received since the previous Monthly Meeting (30th May, 1923), amounting to 3 Vols, 70 Parts or Nos. 11 Bulletins, 0 Reports and 1 Pamphlet, etc., received from 44 Societies and Institutions and 3 private donors were laid upon the table

ORDINARY MONTHLY MEETING

25th JULY, 1923

Mr A F Basset Hull, President, in the Chair

The President announced that the Society had purchased the property known as Lauriston Hall, 16 College Street, with the intention, when the existing lease expires, of occupying portion of the building as the home of the Society

The President also reminded members that Mr Sloane's suggestion that all areas in New South Wales with altitude greater than 4,000 feet should be reserved, would be a subject for special discussion at the August meeting

The result of the ballot as to the hour at which business shall commence at the general meetings of the Society was announced as follows For 7.30 p.m., 37, for 8 o'clock, 6

PAPERS READ

1 A revision of the Australian species of the genus *Bassia*. By R H Anderson, B.Sc (Agr)

2 Anatomical features of the mature sporophyte of *Selaginella uliginosa* By Jessie K Steel (Communicated by Professor A A Lawson)

3 Studies on Australian Mollusca Part xiv By C Hedley

NOTES AND EXHIBITS

Mr Fletcher called attention to the observations of Mr A Goerling, of Perth, W.A., on the way in which the newly-born young of the Kangaroo, unaided by the mother, finds its way to the teat, as recorded in Sir John Bland Sutton's recently delivered Hunterian Oration ["The World's Work," English edition, May, 1923, p. 573]

Mr C Hedley, on behalf of Captain Hurley, showed a series of photographs of pearl shells from the collection of Mr Hockens, of Thursday Island. The series displayed the methods of collecting, of manufacture, and the various species of shells used in the industry.

Dr Greig-Smith exhibited pieces of painted wood which had been sown with the conidia of *Dematium pullulans* and *Cladosporium herbarum*. Recently painted woodwork in Queensland became spotted with dark-coloured patches and it was alleged that the paint had been faulty. But when scrapings were examined, they were found to consist of the dark-coloured conidia of *Dematium* and *Cladosporium*. When watery suspensions of these two moulds were spotted on pieces of light painted wood and kept in a moist atmosphere, the *Dematium* produced the dark patches upon the wood exhibited. *Cladosporium* did not affect the wood.

Mr E Cheel exhibited a fine series of specimens in different stages of development, showing F₁, F₂ and F₃ races of a supposed hybrid *Acacia* (*A. dealbata* X *A. Baileyana*), from plants cultivated at Hill Top. He also exhibited specimens of supposed hybrids found by Mr L. O. Gaillard at Carlingford and Epping, growing spontaneously, and suggested that the characters agree with descriptions of *Acacia adenophora* Spreng., collected by Sieber in Port Jackson District in 1822. The latter somewhat resembles *Acacia decurrens* Willd. (*A. decurrens* var. *normalis* Benth.), but is easily separated from that species, and

it is just possible that *Acacia Nabonnaudi* G V Nash, recently described and figured in *Addisonia*, Vol 6 (1921), plate 197, also supposed to be produced by crossing *A dealbata* and *A decurrens*, on the littoral of the Mediterranean, is not in any way different from *A adenophora*. Mr Cheel suggested that *A. errorata* of Sieber, was probably identical with *A. pauciglandulosa*, if so, Sieber's name has priority over Mueller's *pauciglandulosa*. The latter breeds true and is specifically distinct.

Mr A A Hamilton exhibited seeds of *Cladium jamaicense* Cranz which have been immersed in fresh water from August, 1918 to date, and are still afloat (See also These Proceedings, xlv, p 498), and seeds of *Carex pumila* Thunb, immersed in sea water December, 1918. About one-third of the seeds sank within two years, the balance retaining their buoyancy up to the present time.

The Donations and Exchanges received since the previous Monthly Meeting (27th June, 1923), amounting to 13 Vols, 84 Parts or Nos, 11 Bulletins, 7 Reports and 4 Pamphlets, etc, received from 64 Societies and Institutions and 1 private donor were laid upon the table.

ORDINARY MONTHLY MEETING

29th AUGUST, 1923

Mr A F Basset Hull, President, in the Chair

Mr Emanuel J Hajny, Consul-General for Czechoslovakia in Australia, 40 Hayswater Road, Darlinghurst, and Miss Heather R Drummond, "Havilah," Glenbrook, were elected ordinary members of the Society.

PAPERS READ

1 Studies in life-histories of Australian Diptera Brachycera. II Asilidae No 1 Catalogue of the species of Asilidae of which the earlier stages have been recorded. By Vera Irwin-Smith B.Sc., F.L.S., Linnean Macleay Fellow of the Society in Zoology.

2 Studies in life-histories of Australian Diptera Brachycera. II Asilidae No 2 Notes on the egg-laying, eggs and young larvae of *Neoratus hercules* Wied. By Vera Irwin-Smith, B.Sc., F.L.S., Linnean Macleay Fellow of the Society in Zoology.

3 Studies in Symbiosis. V A contribution to the physiology of *Gastrodia sesamoides* (R.Br.) By John McLuckie, M.A., D.Sc.

4 Studies in plant pigments. I The yellow colouring-matter of the Acacias. By J M Petrie, D.Sc., F.I.C., Linnean Macleay Fellow of the Society in Biochemistry.

5 Revision of the Amycterides (Coleoptera) Part VIII The Euomides. By E W Ferguson, M.B., Ch.M.

The discussion on the proposal for the reservation of all areas in New South Wales with altitude greater than 4,000 feet was contributed to by Messrs T G Sloane, H J Carter, R T. Baker, E Cheel, G A Waterhouse, D G Stead, Professor L. Harrison, Mr R Dalrymple Hay, and the President.

On the motion of Mr T G Sloane, seconded by Mr H J Carter, it was resolved "that this Society desires to advocate the reservation from alienation and the more conservative administration of the Crown Lands of New South Wales on which grow the upland forests at the sources of the principal rivers for the following considerations (1) the quality and regularity of river supply. (2) the

preservation of undergrowth and timber, and (3) the preservation of the fauna and flora of scientific value, and that the terms of this resolution be conveyed to the State Government for consideration"

NOTES AND EXHIBITS

Mr E Cheel exhibited seedling plants of the "Lemon-scented Ironbark" (*Eucalyptus Staigeriana*) showing distinctive variation in the width of the leaves. Of the 14 plants potted from a seed-pan 9 have narrow-linear leaves not more than $\frac{3}{8}$ of an inch in width. The other five plants are more or less lanceolate, up to $\frac{1}{2}$ of an inch in width in the widest part. There appear to be no intermediate forms between these two distinctive forms.

The Donations and Exchanges received since the previous Monthly Meeting (25th July, 1923), amounting to 11 Vols., 90 Parts or Nos., 19 Bulletins, 1 Report and 1 Pamphlet, etc., received from 57 Societies and Institutions and 5 private donors were laid upon the table.

ORDINARY MONTHLY MEETING

26th SEPTEMBER, 1923

Mr J J Fletcher, M A, B Sc, Vice-President, in the Chair

On the motion of the Chairman it was resolved that this meeting desires to record its appreciation of the late Sir Walter Davidson's services to the State during his term of office as Governor of New South Wales and of his efforts to promote the welfare of all the inhabitants of the State, and that an expression of heartfelt sympathy be conveyed to Dame Margaret Davidson on behalf of members of the Society.

Mr Gustaf Mauritz Landergrén, Secretary, Swedish Chamber of Commerce, Harrington Street, Sydney, Miss Jessie K Steel, B Sc, "Helensburgh," Marion Street, Killara and Miss May M Williams, B Sc, "Bungera," 33 Day Street, Drummoyn, were elected ordinary members of the Society.

The Chairman announced that the Council is prepared to receive applications for four Lannean Macleay Fellowships tenable for one year from 1st March, 1924, from qualified Candidates. Applications should be lodged with the Secretary, who would afford all necessary information to intending Candidates, not later than Wednesday, 7th November, 1923.

PAPERS READ

1 A Revision of the Australian Aneastrianae (Lepidoptera) By A J Turner, M D, F E S

2 A new Conifer from Southern Queensland By C T White

3 The High Temperature Organism of Fermenting Tan-bark Part III By R Greig-Smith D Sc, Macleay Bacteriologist to the Society

4 On some Abnormal Sugar-canes By T Steel

5 On some Australian Galerucides By A M Lea, F E S

Mr D G Stead delivered a short lecture entitled "In Malayan Jungles," illustrated by lantern views.

The Donations and Exchanges received since the previous Monthly Meeting (20th August, 1923), amounting to 4 Vols., 72 Parts or Nos., 2 Bulletins, 5 Reports and 3 Pamphlets, etc., received from 46 Societies and Institutions and 3 private donors were laid upon the table.

ORDINARY MONTHLY MEETING

31st OCTOBER, 1923

Mr A F Basset Hull, President, in the Chair

Miss Thistle Harris, Botany School, The University, Sydney and Miss Hilda Butler, Botany School, The University, Sydney, were elected ordinary members of the Society

A letter was received from Dame Margaret Davidson, returning thanks for sympathy

The President announced that since the last meeting Dr J R L Dixon, a member of the Society, had died

The President reminded candidates for Linnæan Macleay Fellowships, 1924-25, that Wednesday, 7th November, 1923, was the last day for receiving applications

It was decided that, whilst the members were in sympathy with the objects of the newly-formed Australian Forest League, the Society should not affiliate with the League

The President announced that it had been suggested that the Society should have photographs of all members, to be kept as a permanent record, and asked members to assist in attaining this object by forwarding their photographs to the Secretary

PAPERS READ

1 Australian Neuroptera Part iv By P Esben-Petersen (*Communicated by W W Froggatt, FLS*)

2 Australian Neuroptera Part v By P Esben-Petersen (*Communicated by W W Froggatt, FLS*)

3 Note on the genus *Synechocera*, with description of a new species By A Théry (*Communicated by H J Carter, B.A., F.E.S.*)

4 The Strophomenidae from the fossiliferous beds of Bowring, NSW By John Mitchell

5 Mesozoic Insects of Queensland No 10 Summary of Upper Triassic Insect Fauna of Ipswich, Q By R J Tillyard, M.A., D.Sc., F.L.S.

6 The life-history of *Pherosphaera* By Professor A A Lawson, D.Sc.

Papers in Part 3 of the Proceedings for 1923 were discussed

Dr. C Anderson showed some lantern views of the Belubula Caves

The Donations and Exchanges received since the previous Monthly Meeting (26th September, 1923), amounting to 11 Vols., 122 Parts or Nos., 13 Bulletins, 6 Reports and 0 Pamphlets, etc., received from 55 Societies and Institutions and 3 private donors were laid upon the table

ORDINARY MONTHLY MEETING

28th NOVEMBER, 1923

Mr A F Basset Hull President, in the Chair

Dr Denis Adrian Pritchard, B.Sc., M.B., Ch.M., H.M.A.S. Penguin, Sydney, and Mr W L Wearne, Telarah, Collingwood Street, Drummoyne were elected ordinary members of the Society

A letter was received from Mrs. Dixon returning thanks for sympathy

The President announced that the Council had re-appointed Dr J M Petrie and Miss M. I. Collins to Linnæan Macleay Fellowships in Bio-chemistry and Botany respectively for one year from 1st April, 1924, and had appointed

Miss M M Williams and Mr P D F Murray to Fellowships in Botany and Zoology respectively for one year from 1st March, 1924

The President announced that the Foundation Meeting of the Australian Forest League would be held on Wednesday, 5th December, in the Education Department, at 8 p m

PAPERS READ

- 1 New or noteworthy plants from the National Herbarium, Sydney By E Cheel
- 2 Notes on Australian Diptera, with descriptions By J R Malloch (Communicated by Dr E W Ferguson)
- 3 The occurrence of secretory canals in certain Myrtaceous plants By M B Welch, B Sc, A I C
- 4 Preliminary note on the embryo sac of *Styphelia longifolia* (R Br) By Patrick Brough, M A, B Sc, B Sc Ag
- 5 A contribution to our knowledge of the Fucaceae By May M Williams, B Sc
- 6 The high temperature organism of fermenting tan-bark Part iv The effect of chill By R Greig-Smith, D Sc, Macleay Bacteriologist to the Society
- 7 Fissicorn Tachinidae, with description of new forms from Australia and South America By Professor M Bezzi (Communicated by Dr E W Ferguson)

NOTES AND EXHIBITS

Mr E Cheel exhibited specimens of *Banksia Cunninghamii* Sieb (Mount Victoria, December, 1900) This species was originally collected by Allan Cunningham in 1817, who labelled it *B ledifolium* Bentham regarded it as not specifically distinct from *B collina* R Br, and included both names as synonyms of *B collina* Fruiting specimens of the same species collected at Wentworth Falls by Mrs Helms in January, 1922, when compared with *B collina* appear to be sufficiently distinct to be rehabilitated under Sieber's species, which is described in Sprengel's Syst Cur Post, 1827, 47 Mr Cheel also exhibited specimens of *Bertya pomaderroides* F v M, as follows —(a) From Woronora River with oblong lanceolate leaves, varying in length from 1 to 2 inches, and (b) from Cataract Dam, with ovate leaves not exceeding $\frac{1}{2}$ inch long The original specimens were collected at Bent's Basin, and the "Interior" is also mentioned (B Fl, vi, 78) without specific locality

Mr W W Froggatt exhibited (i) The great pine weevil (*Eurhampus fasciculatus* Shue), the larva of which feeds in dead or dying pine trees in the Northern River forests, this was the first live specimen he had seen and it was taken in a pine log cut at Dorrigo and forwarded by Forest Guard J McSkrimmings (ii) The Pittosporum stem longicorn (*Strongylurus thoracicus*) in orange tree stems from the orchard of Mr K Mathewes at Grose Vale (iii) The fig tree longicorn (*Monohammus fistulator*) which had been damaging the wistaria at Vaucluse House Systematic cutting out of the dead wood by the head gardener has probably saved this wistaria, which is over 100 years old, as it is now sending out a fresh growth of young wood The native food plant of several species of *Monohammus* is the wild fig, but this species is an omnivorous feeder and has been bred from old vine and passion fruit stems

Miss M I Collins, Linnean Macleay Fellow of the Society in Botany, exhibited a series of lantern slides illustrating her work on the floras of arid and semi-arid New South Wales

The Donations and Exchanges received since the previous Monthly Meeting (31st October, 1923), amounting to 10 Vols, 202 Parts or Nos, 8 Bulletins, 3 Reports and 2 Pamphlets, etc, received from 56 Societies and Institutions and 3 private donors were laid upon the table

DONATIONS AND EXCHANGES

Received during the period 30th November, 1922, to 28th November, 1923

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TOKYO

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TRING, Herts

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TURIN

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VIENNA

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WASHINGTON

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WELLINGTON, N.Z

Department of Mines New Zealand Geological Survey—*N.S. xlviii Annual Report, 1922-1923* (1923), *Bulletin*, N.S. Nos. 24-25 (1923).

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LIST OF MEMBERS, 1923

ORDINARY MEMBERS

- 1905 Allen, Edmund, c/o Chief Engineer for Railways, Brisbane, Q
- 1906 Anderson, Charles, M.A., D.Sc., Australian Museum, College St., Sydney
- 1922 Anderson, Robert Henry, B Sc Agr Botanic Gardens, Sydney
- 1899 Andrews, Ernest Clayton, B.A., FGS, Geological Survey, Department of Mines, Sydney
- 1912 Auroousseau, Marcel, B Sc, c/o Geo-Physical Laboratory, Carnegie Institution of Washington, Washington, DC, U.S.A
- 1913 Badham, Charles, B Sc, M B, Bureau of Microbiology, 93 Macquarie Street, Sydney
- 1888 Baker, Richard Thomas, The Avenue, Cheltenham
- 1919 Barnett, Marcus Stanley, c/o Colonial Sugar Refining Co, Ltd, O'Connell Street, Sydney
- 1907 Benson, Professor William Noel, B.A., D.Sc., FGS, University of Otago, Dunedin, N Z
- 1920 Blakely, William Faris, Botanic Gardens, Sydney
- 1923 Bone, Walter Henry, 15 Bond Street Sydney
- 1912 Breakwell, Ernest, B A., B Sc, Agricultural High School, Yanco, N S W
- 1914 Bretnall, Reginald Wheeler, "Dardanella," Bowral, N S W
- 1912 Brewster, Miss Agnes, Girls' High School, Sydney
- 1900 Broelemann, Henry W, Boite 22, a Pau (Basses-Pyrenees), France
- 1923 Brough, Patrick, M A B Sc, B Ag Sc "Kinross," Billyard Avenue, Wahroonga
- 1919 Broughton, Miss Eileen Marjorie, B Sc, "Riverview," Glenfield, N S W
- 1921 Brown, Horace William, Post Office, Mackay, Queensland.
- 1911 Browne, William Rowan, D Sc, Geology Dept, University of Sydney.
- 1920 Burkitt, Arthur Neville St George Handcock, M B, B.Sc., Medical School, University of Sydney
- 1921 Burns, Alexander Noble, Prickly Pear Laboratory, Sherwood, Brisbane, Q.
- 1910 Burrell, Harry, 19 Doncaster Avenue, Kensington
- 1910 Burrell Mrs Harry, 19 Doncaster Avenue, Kensington
- 1912 Cadell, Miss Myall, "Wotonga," Belgium Avenue, Roseville
- 1899 Cambage, Richard Hind, L.S., FLS, Park Road, Burwood
- 1901 Campbell, John Honeyford, M B E, Royal Mint, Sydney
- 1906 Carne, Walter Mervyn, Government Botanist, Perth, W A
- 1890 Carson, Duncan, c/o Winchcombe, Carson, Ltd., Bridge St., Sydney
- 1908 Carter H J, B.A., F.E.S., "Garrawillah," Kintore St, Wahroonga
- 1904 Chapman, Professor Henry G., M.D., BS, Medical School, University of Sydney
- 1921 Chase Miss Eleanor Emily, B.Sc., Zoology Department, The University, Sydney
- 1899 Cheel, Edwin, Botanic Gardens, Sydney
- 1920 Clarke Harry Flockton, c/o Colonial Sugar Refining Co, Ltd, Rarawa Mill, Ba River Fiji
- 1901 Cleland, Professor John Burton, M.D., Ch M., The University, Adelaide, S A.
- 1916 Collins Miss Marjorie Isabel, B Sc, Macleay Museum, The University, Sydney
- 1908 Cotton Leo Arthur, M.A., D.Sc., Geology Dept, University of Sydney.
- 1921 Cowled Mrs S G C (nee Miss Grace Anderson), B.Sc Methodist Mission Station, Bwaidoga, Papua.
- 1900 Crago, William Henry, M D, 185 Macquarie Street, Sydney.

- 1920 Danes, Dr Jan Victor Charles University, Prague, Czechoslovakia, Europe
 1885 David, Sir Tannatt William Edgeworth, KBE, CMG, DSO, BA, DSc
 FRS, University of Sydney
 1883 Deane, Henry, MA FLS, MInstCE, "Campae," 14 Mercer Road Mal-
 vern, Melbourne, Victoria
 1916 Deer, Miss Margaret, B.A., BSc, 37 Milson Road, Watersleigh
 1887 Dixon Sir Hugh, Kt, JP, "Abergeldie," Summer Hill
 1881 Dixon, Thomas Storie, MB, ChM, 215 Macquarie Street, Sydney
 1921 Dodd, Alan Parkhurst, Prickly Pear Laboratory, Sherwood, Brisbane, Q
 1923 Drummond Miss Heather R, "Havilah" Glenbrook NSW
 1920 Dwyer, Rt Rev Joseph Wilfrid, Bishop of Wagga, Wagga Wagga, NSW

 1920 Elston Albert H FES "Hatherley" Unley Park SA
 1914 Enright, Walter John, BA, West Maitland, NSW

 1906 Ferguson, Eustace William, MB, ChM, Bureau of Microbiology, Macquarie
 Street, Sydney
 1906 Finckh, Herman E, "Hermes" 100 Raglan Street, Mosman
 1881 Fletcher, Joseph J, MA, BSc, Woolwich Road, Woolwich
 1908 Flvnn, Professor Theodore Thomson, DSc, University of Tasmania Hobart,
 Tas
 1920 Friend, Norman Bartlett, 42 Pile Street, Dulwich Hill
 1911 Froggatt, John Lewis, BSc, Dept of Agriculture, Brisbane
 1886 Froggatt Walter Wilson FLS, Young Street, Croydon
 1920 Furst, Herbert Charles, "Hermesley," Tupper Street, Marrickville

 1912 Goldfinch, Gilbert M, "Lyndhurst," Salisbury Road, Rose Bay
 1899 Grant, Robert, 24 Edward Street, Woollahra
 1923 Gray, Archibald James "Warwick," Fernhill Street Hurlstone Park
 1911 Greenwood, William Frederick Neville, c/ Colonial Sugar Refining Co, Ltd,
 Lautoka, Fiji
 1910 Griffiths, Edward, BSc, Dept of Agriculture, 136 Lower George St, Sydney
 1901 Gurney, William B, FES, Dept of Agriculture, George St North, Sydney

 1911 Hacker, Henry, Queensland Museum, Bowen Park, Brisbane, Q
 1923 Hajny Emanuel J, Consul-General for Czechoslovakia, 40 Bayswater Road,
 Darlinghurst
 1909 Hall, E Outhbert, MD, ChM, George Street, Parramatta
 1919 Hall, Leslie Lionel, 51 Macquarie Street, Sydney.
 1897 Halligan, Gerald H, FGS, 97 Elphin Road, Launceston, Tasmania
 1899 Hamilton Arthur Andrew, "The Ferns," 17 Thomas Street, Ashfield
 1885 Hamilton, Alexander Greenlaw, "Tanandra," Hercules Street Chatswood
 1922 Hardwick, Frederick George, B D S, D D Sc, Molesworth Street, Lismore,
 NSW
 1917 Hardy, G H. Hurlstone The University Brisbane, Q
 1906 Harrison, Professor Launcelot, B Sc, BA, Zoology Dept. University of
 Sydney
 1879 Haswell, Professor William Aitchison, M.A., DSc, FRS, "Mimihaui,"
 Woollahra Point
 1911 Haviland, The Venerable Archdeacon F E St Thomas' Rectory, O'Connell
 NSW
 1891 Hedley, Charles, FLS, Australian Museum, College St, Sydney
 1920 Henry, Marguerite, BSc, "Derwent," Oxford St, Epping
 1909 Henry, Max, DSO, MRCVS, BVSc, Coram Cottage, Essex Street,
 Epping
 1913 Hill, Gerald F, F.E.S., 5 Clifton Road Hawthorn, Melbourne Victoria
 1916 Hinder, Miss Eleanor B Sc, c/- Farmer's, Ltd George and Market Sts
 Sydney
 1916 Hindmarsh, Miss Ellen Margaret, BSc, Medical School, The University of
 Sydney

- 1922 Hitchcock, Leith Fuller, Prickly Pear Laboratory, Sherwood Brisbane, Q
 1918 Hopson, John, Jr, "Dalketh," Eccleston, NSW
 1907 Hull, Arthur Francis Basset, Box 704, G.P.O., Sydney
 1892 Hynes, Miss Sarah, B.A., "Isis," Soudan Street, Randwick
 1912 Irby, Llewellyn George, Forestry Dept Hobart Tasmania
 1912 Jackson, Sidney William, M.R.A.O.U., Belltrees, via Scone, NSW
 1917 Jacobs, Ernest G, "Cambria," 106 Bland Street Ashfield
 1903 Jensen Harald Ingemann D.Sc., Treasury Chambers, George St Brisbane,
 Q
 1907 Johnston, Professor Thomas Harvey, M.A., D.Sc., The University, Adelaide,
 S.A.
 1921 Kennedy, John A., M.B., Ch.M., 423 Marrickville Road, Dulwich Hill.
 1913 Lawson, Professor Abercrombie Anstruther D.Sc., F.R.S.E., Botany Dept.,
 University of Sydney
 1923 Lawson Augustus Albert, 9 Wilmot St., Sydney
 1892 Lea, Arthur M., F.E.S., 241 Young Street, Unley, Adelaide, S.A.
 1915 Le Plastrier, Miss Constance Emily Mary, "Carnnyah," Provincial Road,
 Lindfield
 1910 Le Souef, A.S., C.M.Z.S., Zoological Gardens, Taronga Park, Mosman
 1923 Lindergren, Gustaf Mauritz Secretary, Swedish Chamber of Commerce,
 Carrington Street, Sydney
 1891 Lower, Oswald B., F.E.S., Bartley Crescent, Wayville, S.A.
 1893 Lucas, A.H.S., M.A., B.Sc., "Gurrahween" William St Roseville
 1922 Mackerras, Ian Murray, "Beechworth," Stanton Road, Mosman
 1911 Mackinnon Ewen, B.Sc., Commonwealth Institute of Science and Industry,
 314 Albert Street, East Melbourne
 1893 Maiden, J. Henry, I.S.O., F.R.S., F.L.S., Botanic Gardens, Sydney
 1905 Mawson, Sir Douglas M.B.E., D.Sc., F.R.S. The University, Adelaide, S.A.
 1902 May, W.L., Forest Hill, Sandford, Tasmania
 1919 McCarthy, T., Bertram Street, Mortlake
 1907 McCulloch, Allan Riverstone, Australian Museum, College Street, Sydney
 1907 McDonnough, Thomas L.S., "Iluka," Hamilton Street, Randwick
 1917 McKeown, Keith Collingwood, Office of the Water Conservation and Irriga-
 tion Commission, Leeton, NSW
 1919 McLuckie, John, M.A., D.Sc., Botany Dept., The University, Sydney
 1884 Mitchell John, 10 High Street, Waratah, NSW
 1922 Moulden, Owen Meredith M.B., B.S., "Roma," Unley Road, Adelaide, S.A.
 1904 Murdoch, R., Wanganui, New Zealand
 1922 Murray, Patrick Diamond Fitzgerald, B.Sc., Magdalen College, Oxford
 University Oxford, England
 1920 Musgrave, Anthony, Australian Museum, College St., Sydney
 1888 Musson, Charles T., "Calala," Nelson Road, Gordon
 1913 Newman, Leslie John William, "Walthamstowe," Bernard St., Claremont,
 Perth, W.A.
 1922 Nicholson, Alexander John, M.Sc., Zoology Dept., The University, Sydney
 1920 Noble Robert Jackson, B.Sc. Agr. Ph.D. Biological Branch, Dept. of
 Agriculture George Street North Sydney
 1912 North David Sutherland, c/ Colonial Sugar Refining Co. Ltd, O'Connell
 St., Sydney
 1920 O'Dwyer Margaret Helena, B.Sc. Bio-chemistry Dept., Imperial College of
 Science, South Kensington, London, S.W.7, England
 1910 Oliver, W. Reginald B., F.L.S., F.Z.S., Dominion Museum, Wellington, N.Z.
 1921 Osborne, George Davenport, B.Sc., Geology Dept., The University, Sydney
 1922 Perkins, Frederick Athol, B.Sc. Agr., Post Office, Stanthorpe, Queensland.
 1923 Petrie, Arthur Hill Kelvin, Wonga Street, Strathfield.

LIST OF MEMBERS.

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- 1904 Petrie, James Matthew, DSc, FIC, Medical School, University of Sydney
 1921 Phillips, Montagu Austin, F L S, 57 St George's Square, London, S W, England
 1920 Pincombe, Torrington Hawke, BA, Russell Road, New Lambton, NSW
 1918 Pinkerton, Miss Ethel Corry, BSc, Ashford Street, Ashfield
 1918 Priestley, Henry, MD, BSc, Medical School, University of Sydney
 1910 Pulleine, Robert Henry, MB, 3 North Terrace, Adelaide, S.A

 1919 Scammell, George Vance, 18 Middle Head Road, Mosman
 1922 Shaw, Alfred Eland, M R C S, L R C P, F E S, Hospital for the Insane, Goodna, Queensland
 1918 Sherrie, Miss Heather, BSc, Ben Boyd Road, Neutral Bay
 1887 Sloane, Thomas G, Moorilla, Young, NSW

 1909 Smith, G P Darnell, DSc, FIC, FCS, Agricultural Museum, George St North, Sydney
 1899 Smith, Henry George, FCS, "Dunbourne, Shirley Road, Roseville
 1898 Smith, R Greig, DSc, Linnean Hall, Elizabeth Bay
 1916 Smith, Miss Vera Irwin, BSc, FLS, "Cora Lynn," Point Road, Woolwich
 1898 Stead, David G, "Boongarre," Pacific St, Watson's Bay
 1923 Steel, Miss Jessie Keeble, BSc "Helensburgh" Marion Street, Killara
 1886 Steel, Thomas, 'Rock Bank' Stephen Street, Pennant Hills
 1905 Stokes, Edward Sutherland, MB, ChM, Dept of Water Supply and Sewerage, 341 Pitt Street, Sydney
 1911 Sulman, Miss Florence, "Burrangong," McMahon's Point
 1904 Sussmilch, C A, FGS, Technical College, Newcastle, NSW

 1920 Taylor, Augustus Selwyn, JP, Asst Govt Geologist, Entebbe, Uganda, British East Africa
 1907 Taylor, Frank H, c/- Box 137, GPO, Sydney
 1920 Tebbutt, Arthur Hamilton, MB, 185 Macquarie Street, Sydney
 1923 Thackway, Albert Edward John 'Wyoming' Albyn Road, Strathfield
 1922 Tiegs, Oscar Werner, MSc, The University, Adelaide, S A
 1916 Tilley, Cecil Edgar, Ph D BSc, A I C, FGS Sedgwick Museum University of Cambridge, Cambridge England
 1904 Tillyard, Robin John, DSc, MA, FLS, FES, CMZS, Cawthron Institute, Nelson, New Zealand
 1921 Troughton, Ellis Le Geyt, Australian Museum College Street, Sydney.
 1902 Turner, A Jefferis, MD, FES, Wickham Terrace, Brisbane, Q
 1904 Turner, Rowland E F E S F Z S The Needles Hotel, Port St John's, Pondoland, South Africa

 1917 Veitch, Robert, BSc, c/- Colonial Sugar Refining Co, Ltd, Lautoka Mill, Lautoka, Fiji

 1900 Walker, Commander John James, MA, FLS, FES, RN, "Aorang," Lonsdale Road, Summertown, Oxford, England
 1909 Walkom, Arthur Bache, DSc, Linnean Hall, Elizabeth Bay.
 1911 Wardlaw, Henry Sloane Halcro, DSc, Physiology Dept, University of Sydney
 1897 Waterhouse, Gustavus Athol, BSc, BE, FES, Royal Mint, Macquarie St, Sydney
 1911 Watt, Professor Robert Dickie, MA, BSc, University of Sydney
 1922 Welch, Marcus Baldwin, BSc, A I C, Technological Museum, Harris Street, Ultimo
 1916 Welch, William, FRGS, "Roto-iti," Boyle Street, Mosman
 1916 White, Cyril Tension, Botanic Gardens Brisbane, Q
 1910 White, Henry Luke, Belltrees, Scone, NSW

- 1923 Williams, Miss May Marston B Sc, "Bingera" 33 Dav Street, Drummoyne.
 1903 Woolnough, Walter George, D Sc, FGS, University of Sydney
 1910 Wymark, Frederick, 89 Castlereagh Street Sydney

HONORARY MEMBERS

- 1897 De Toni, Dr G B, R Orto Botanico di Modena, Italy
 1923 Hill, Professor J P, Institute of Anatomy, University of London, University College, Gower Street, London, W C 1, England
 1923 Wilson, Professor J T, M B, Ch M F R S Department of Anatomy, The New Museums Cambridge, England

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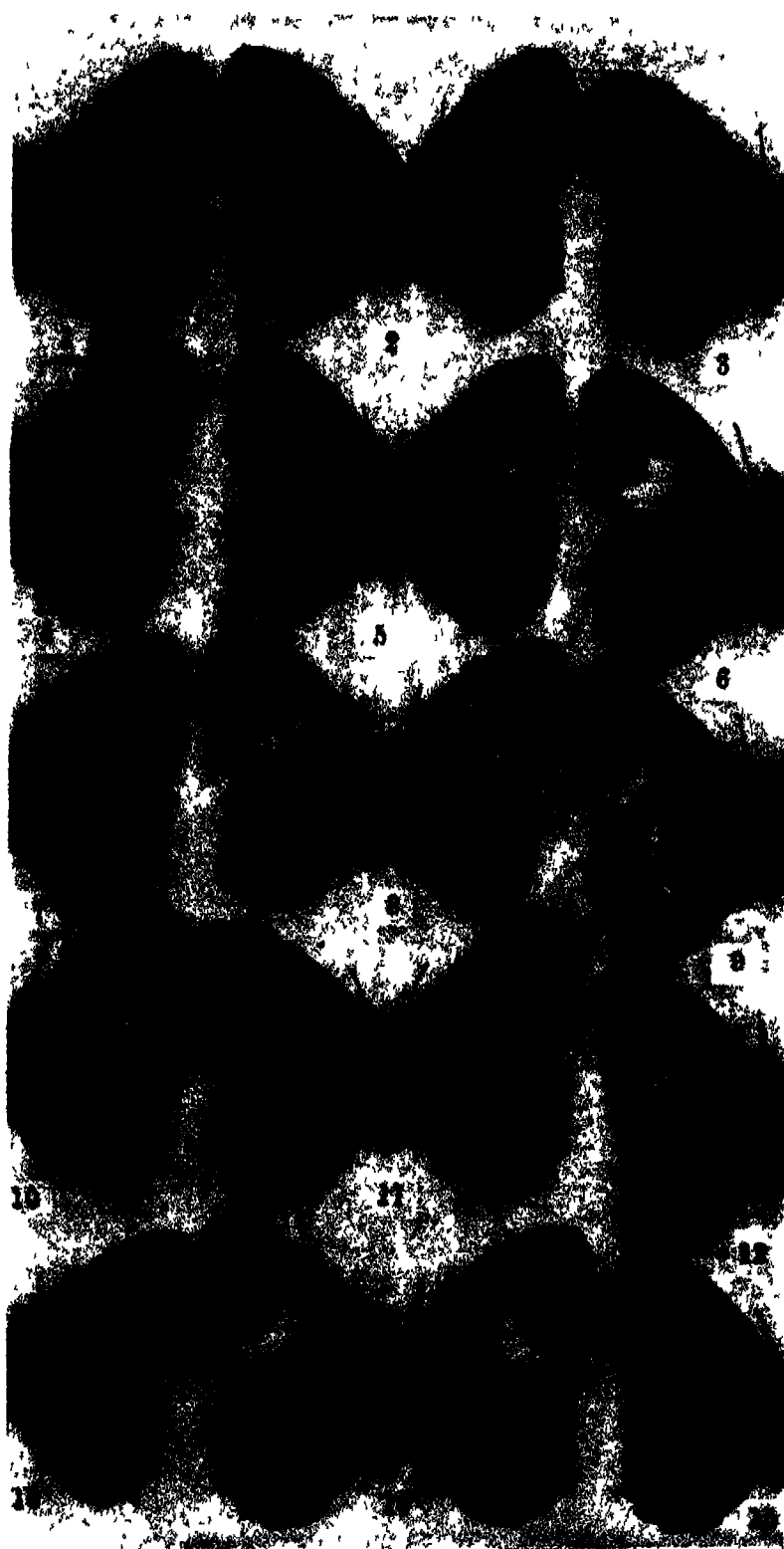
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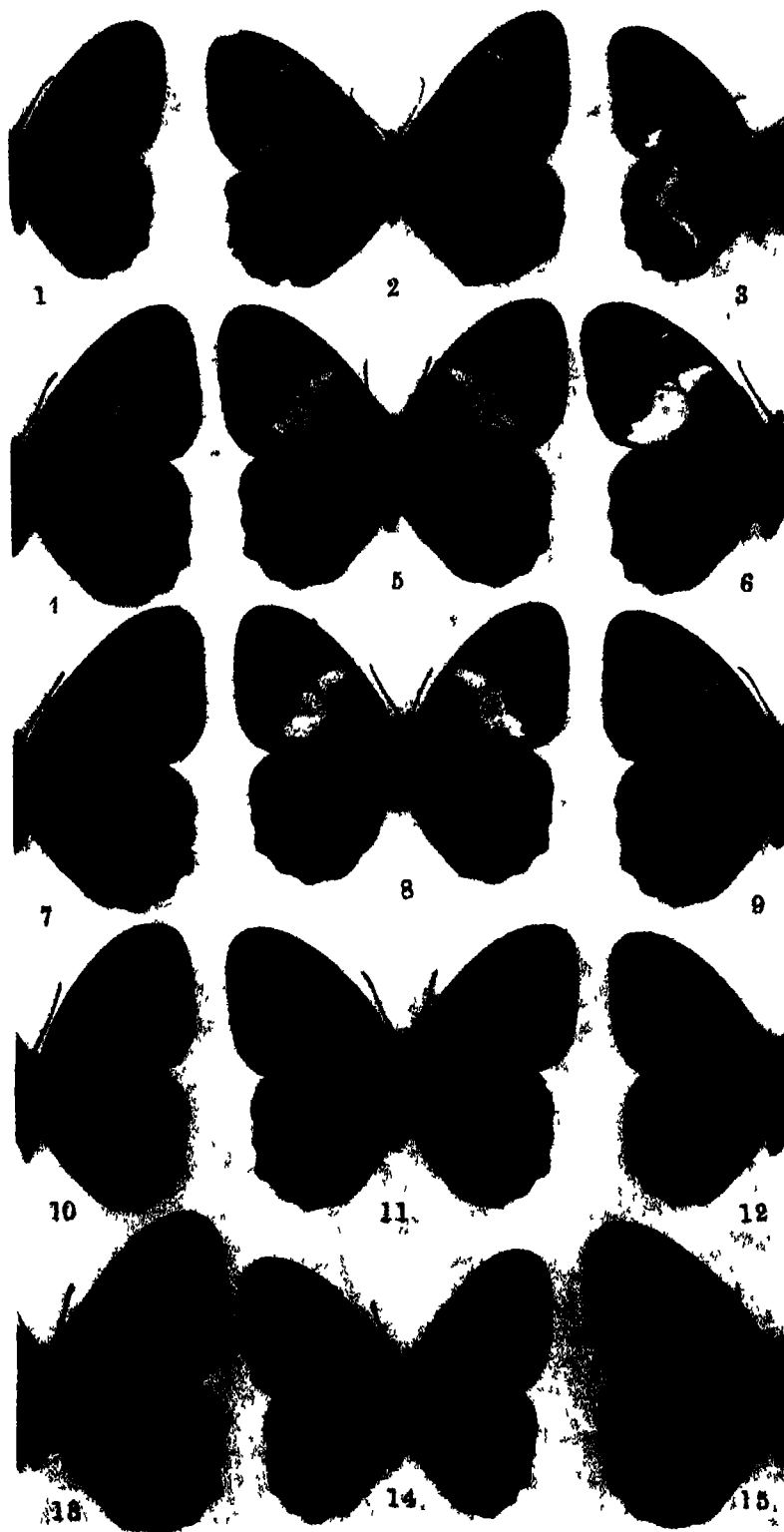
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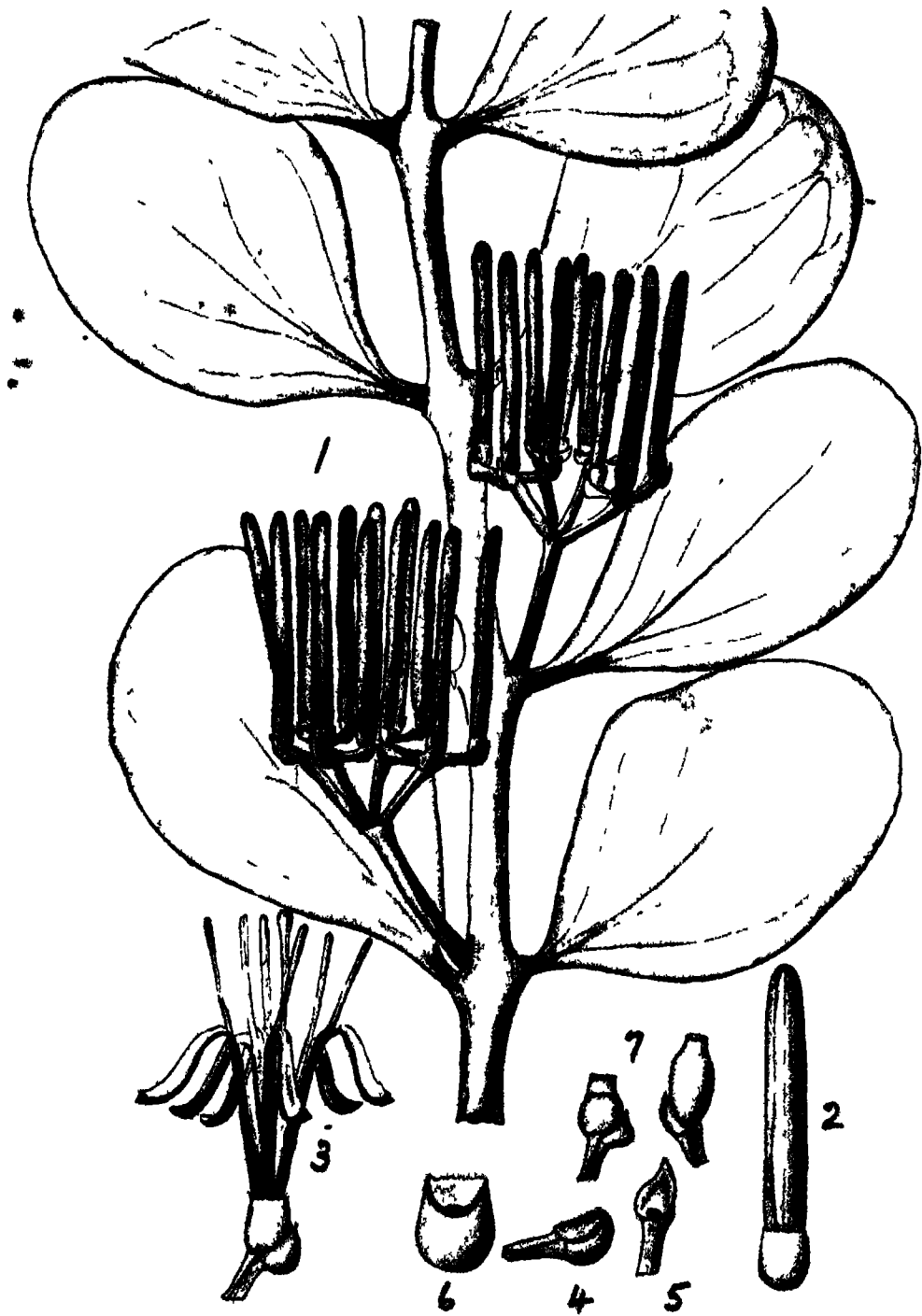
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Approximately four-fifths natural size

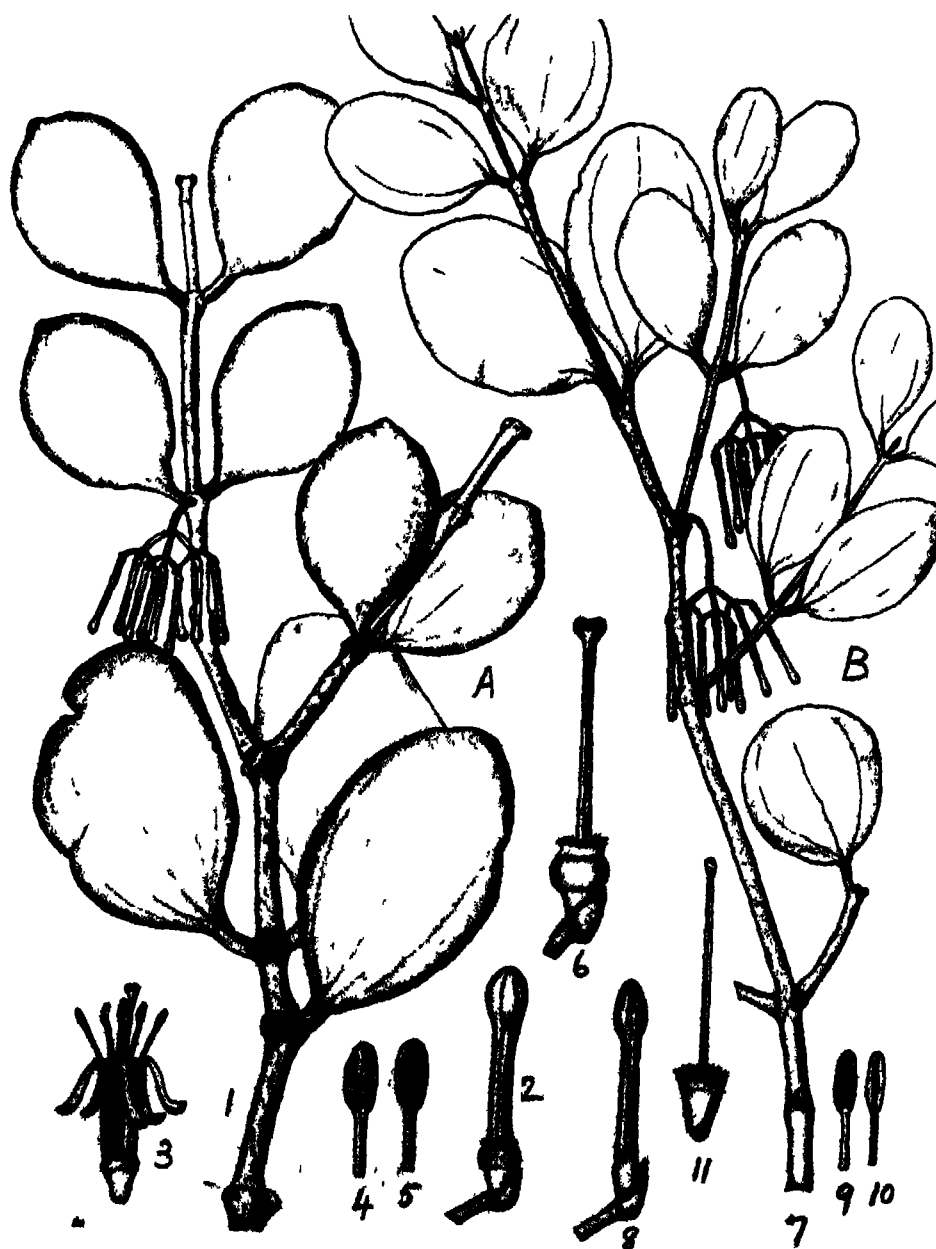


Approximately four-fifths natural size



Loranthus Queenslandicus, n. sp.

W F B del

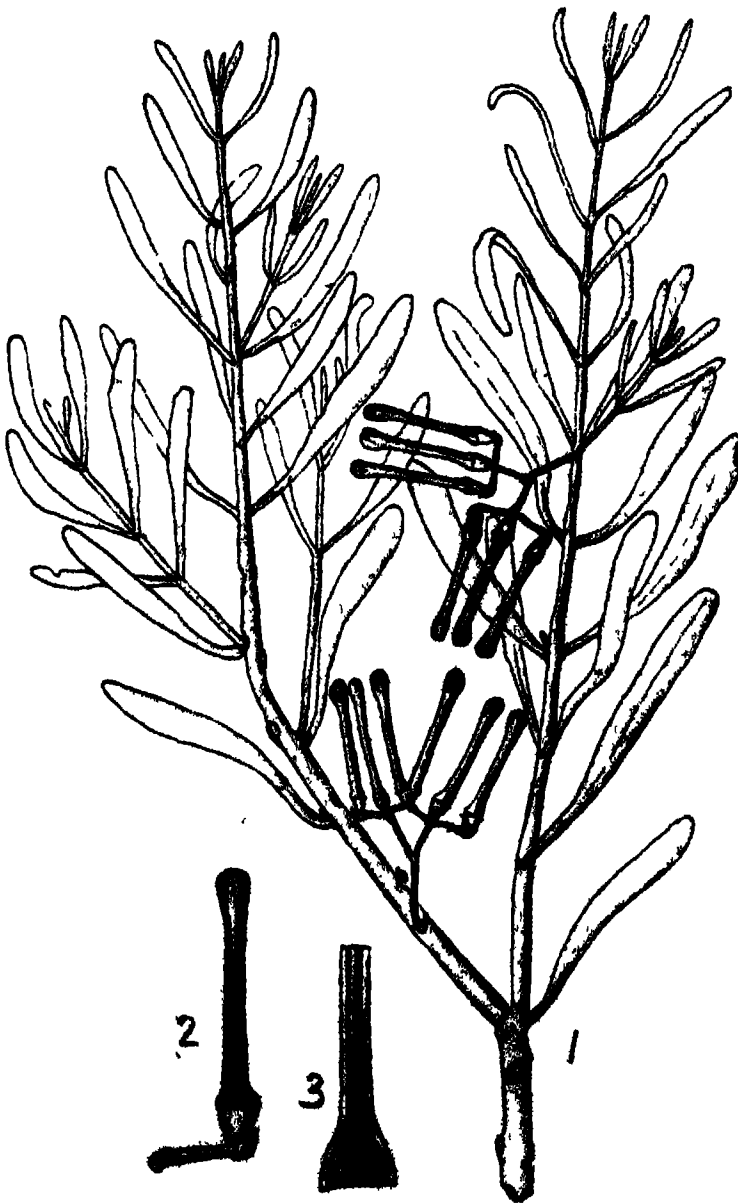


A *Loranthus Cygneus-Sinus*, n sp B *L. Mackayensis*, n sp
W F B del

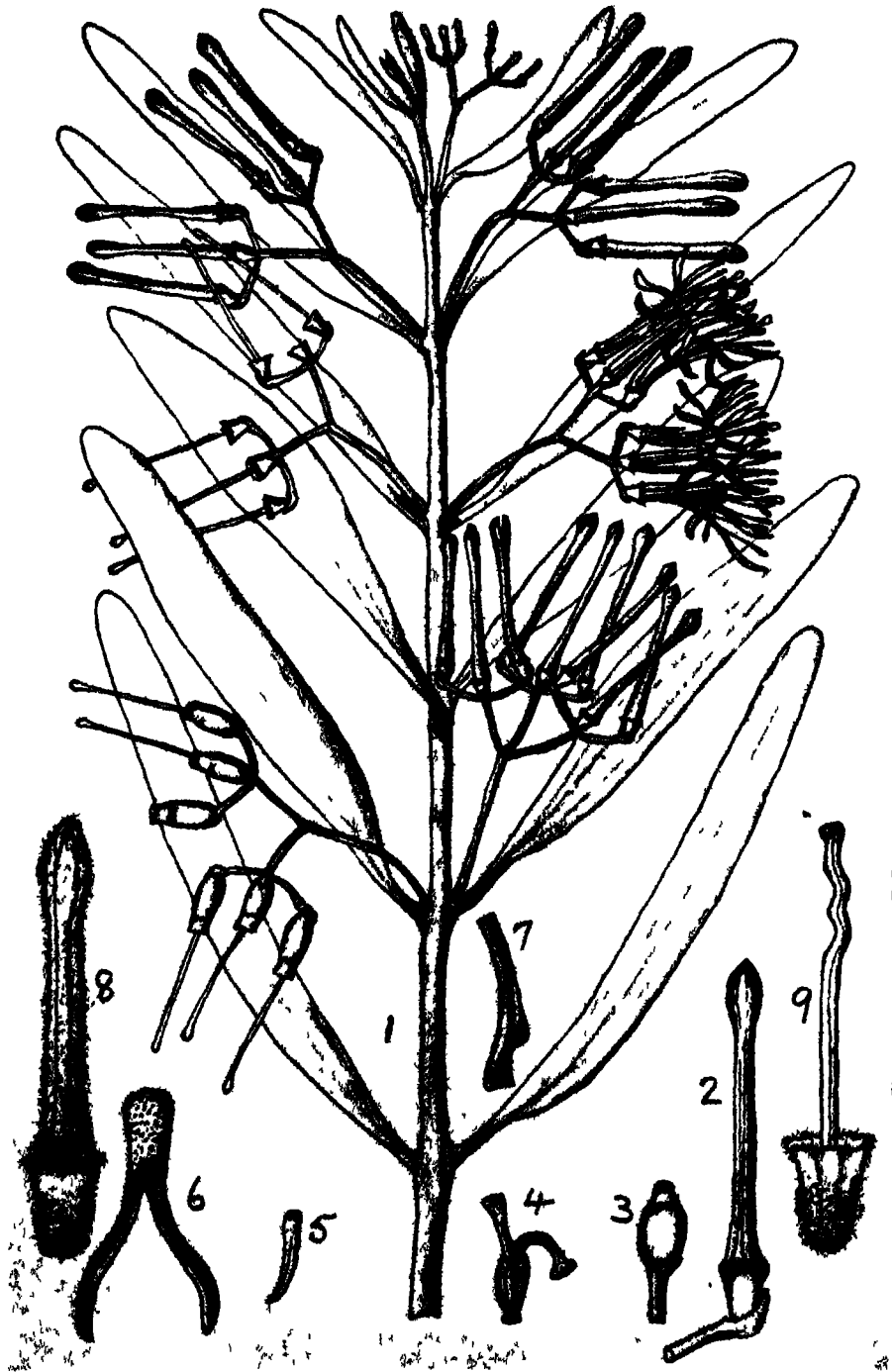


Loranthus unguiculatus Miq

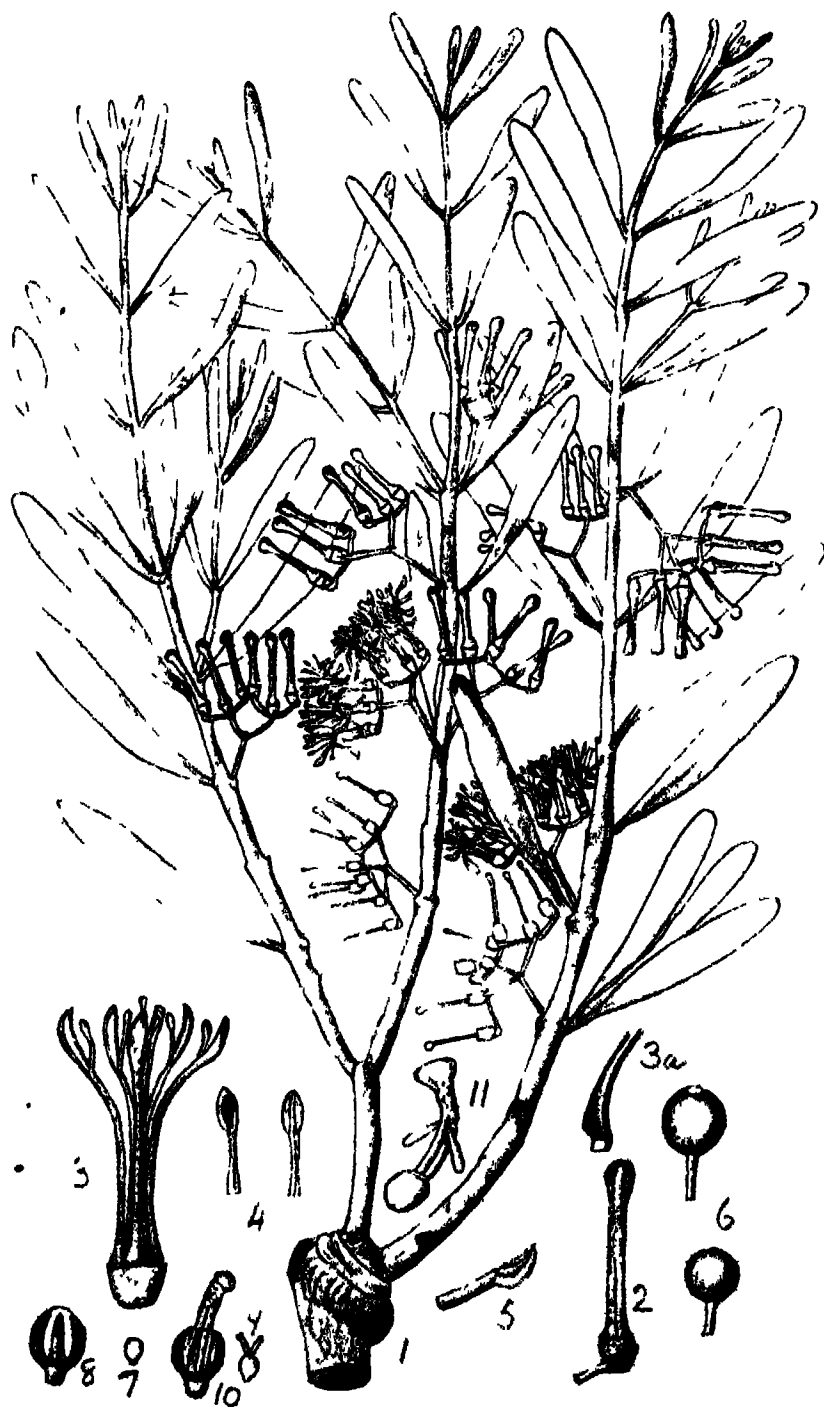
W F B del



Loranthus miraculosus Miq. var. *Metaleucæ* (Tate), n. comb.
W. F. B. del.

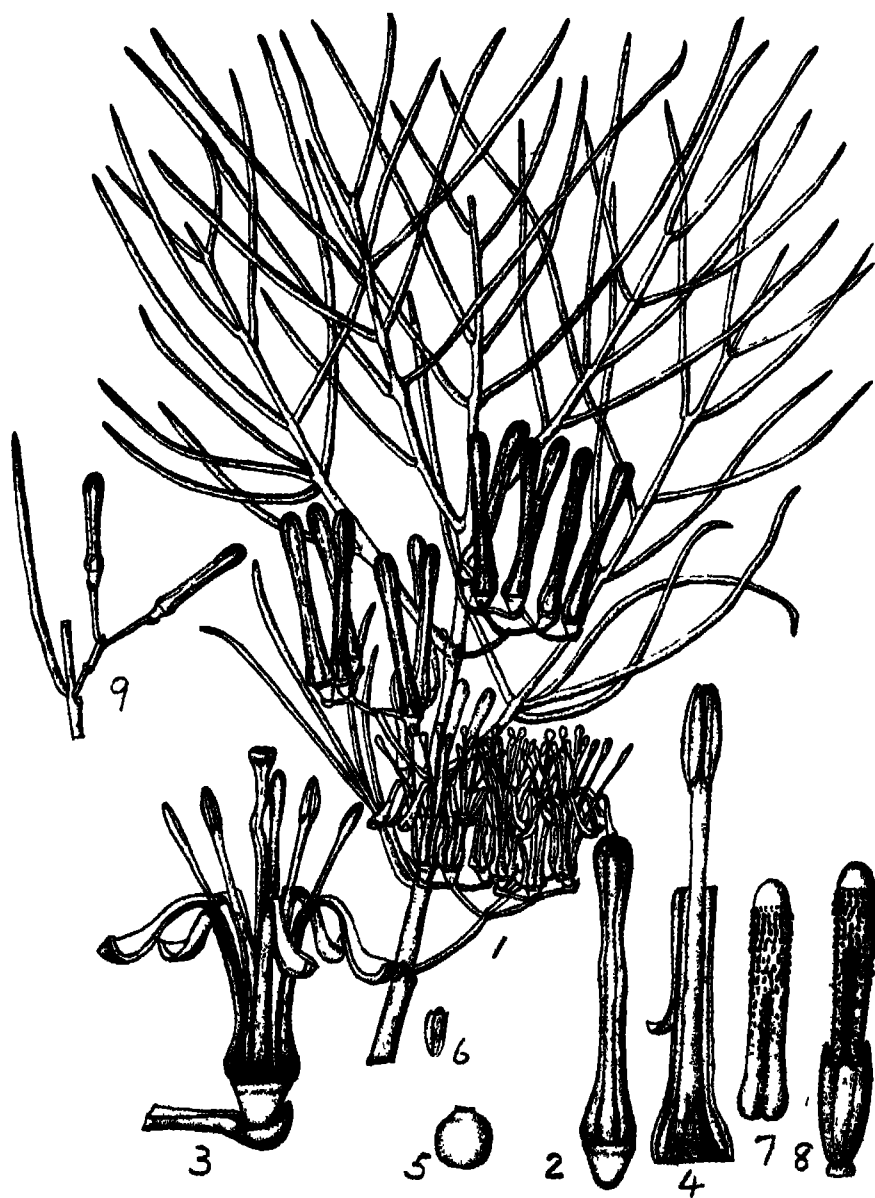


1-7 *Loranthus unguiculatus* Miq. var. *Boormanii* 8, 9 *L. unguiculatus*
var. *pubigera*, n. var.
W. F. B. del.



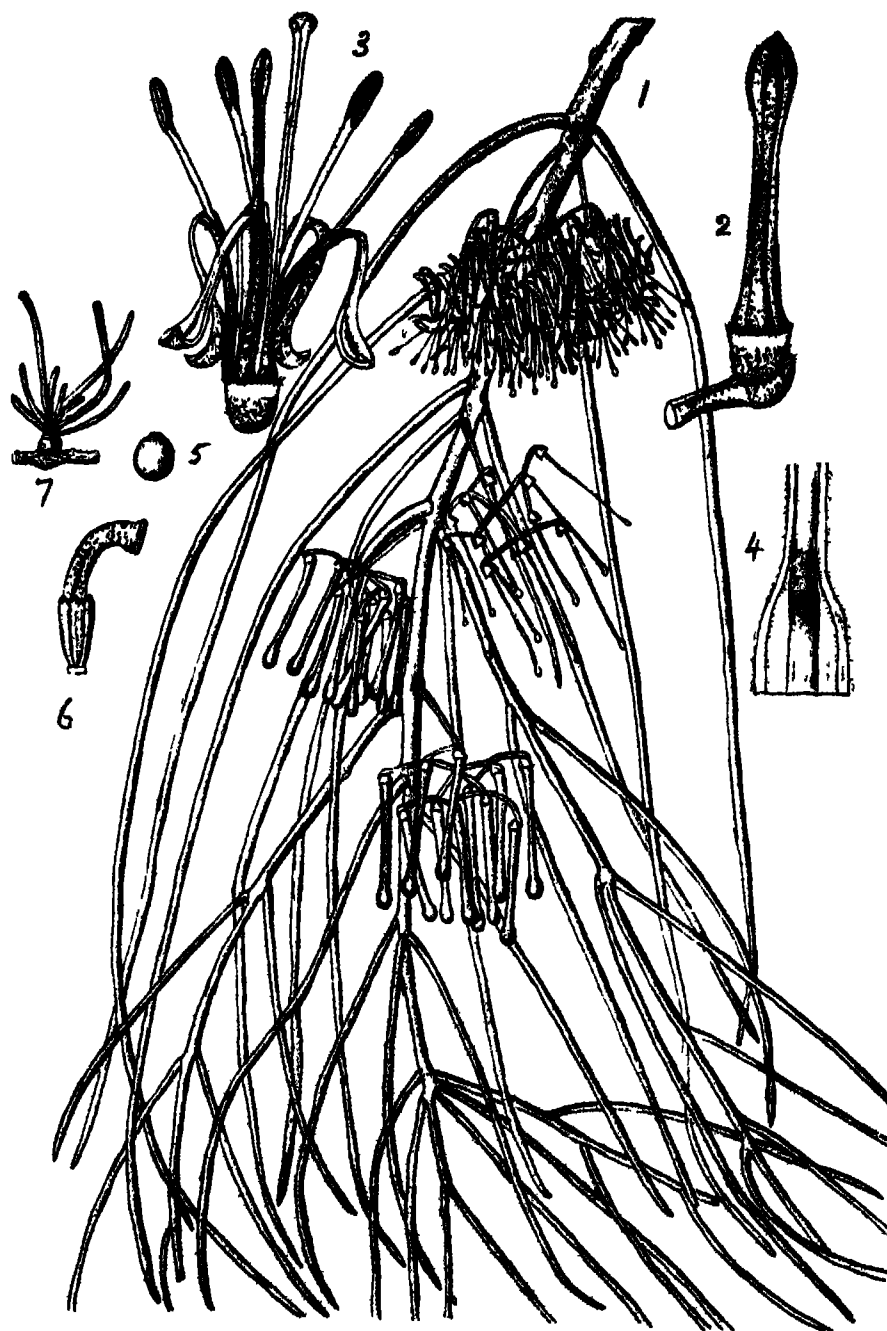
Losanthus Gaudichandi DC

W F.B. del



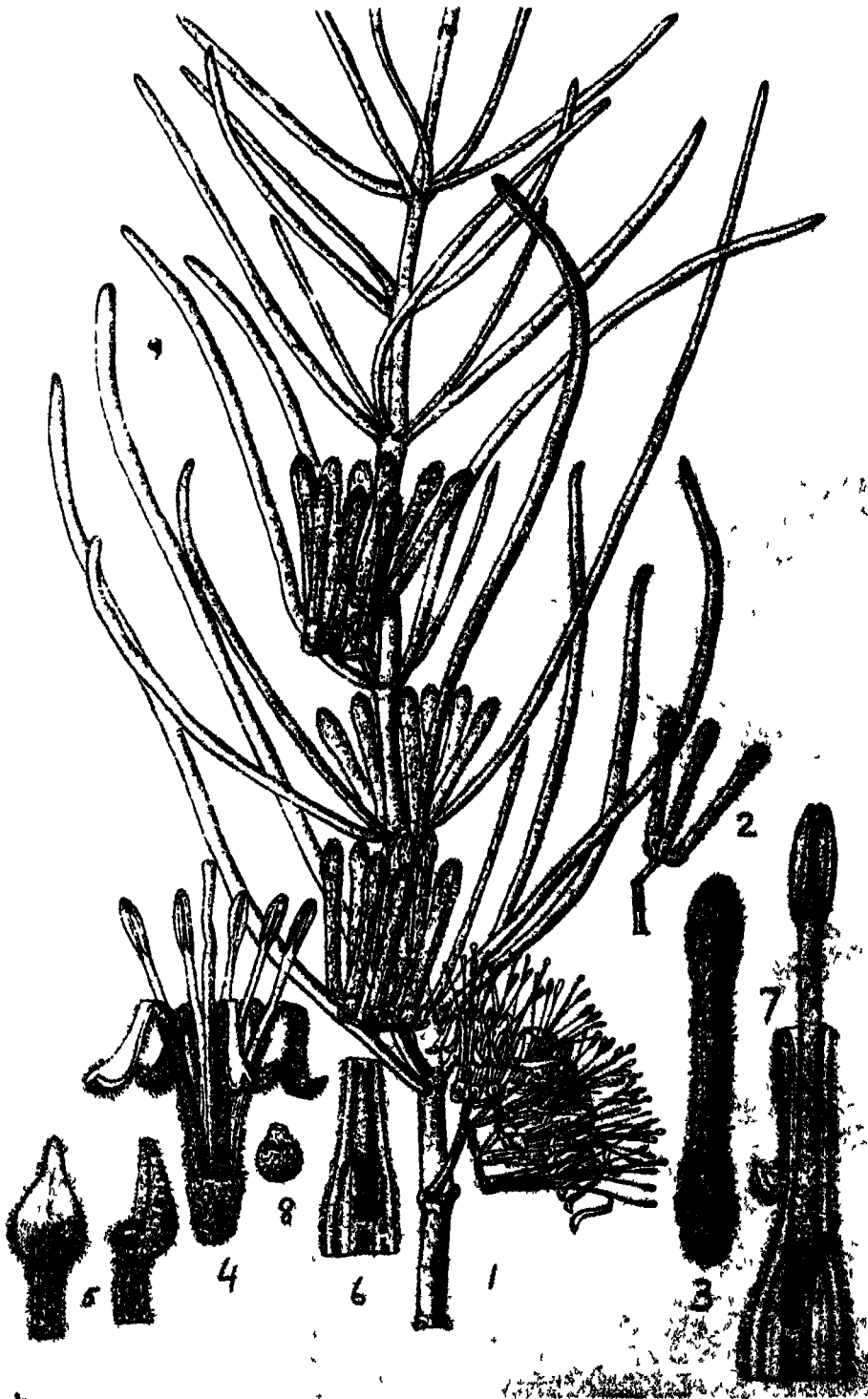
Loranthus Preissii Miq

W F B del



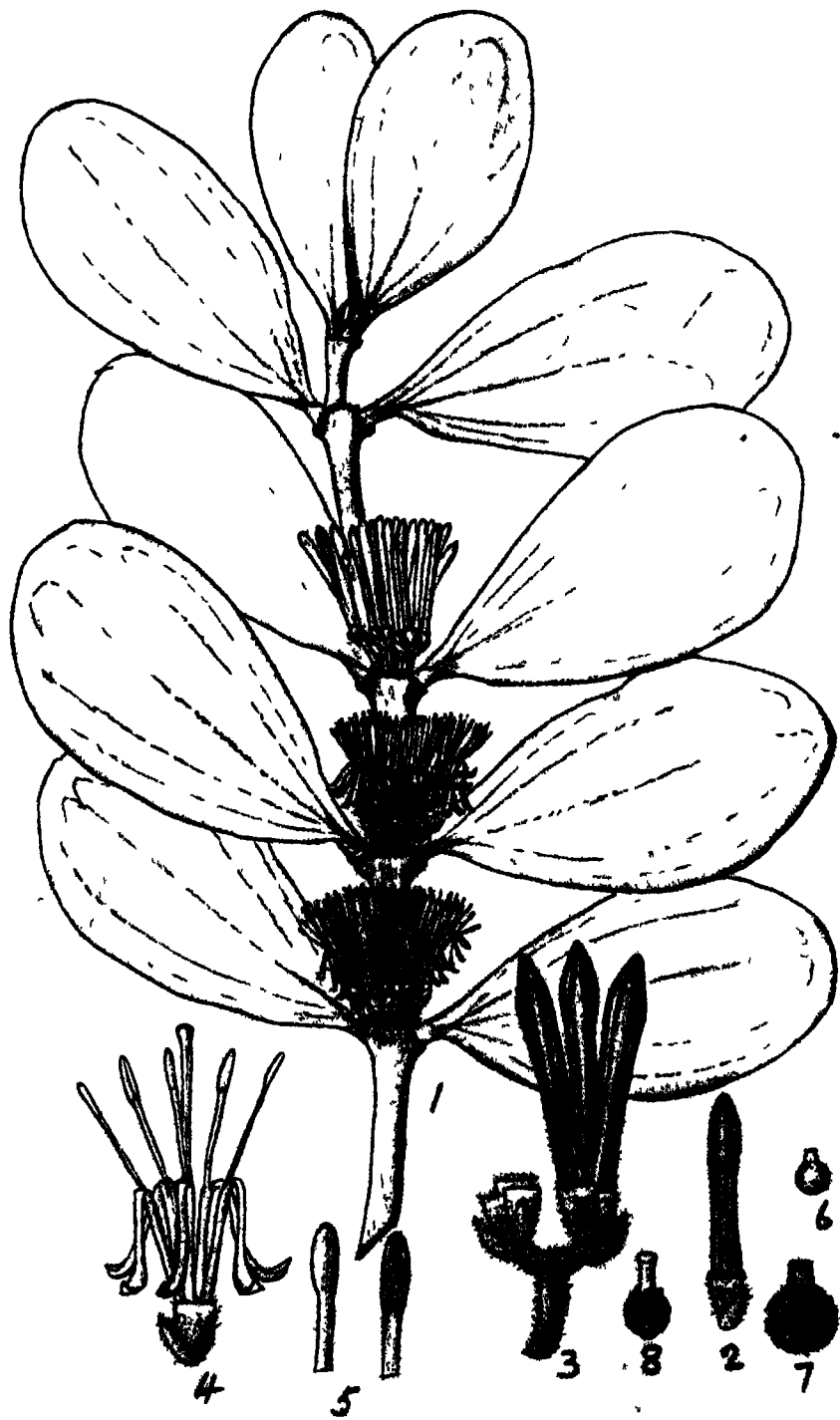
Loranthus Cambagesii, n. sp

W F B del.



Loranthus linophyllus Fenzl

W F.B del



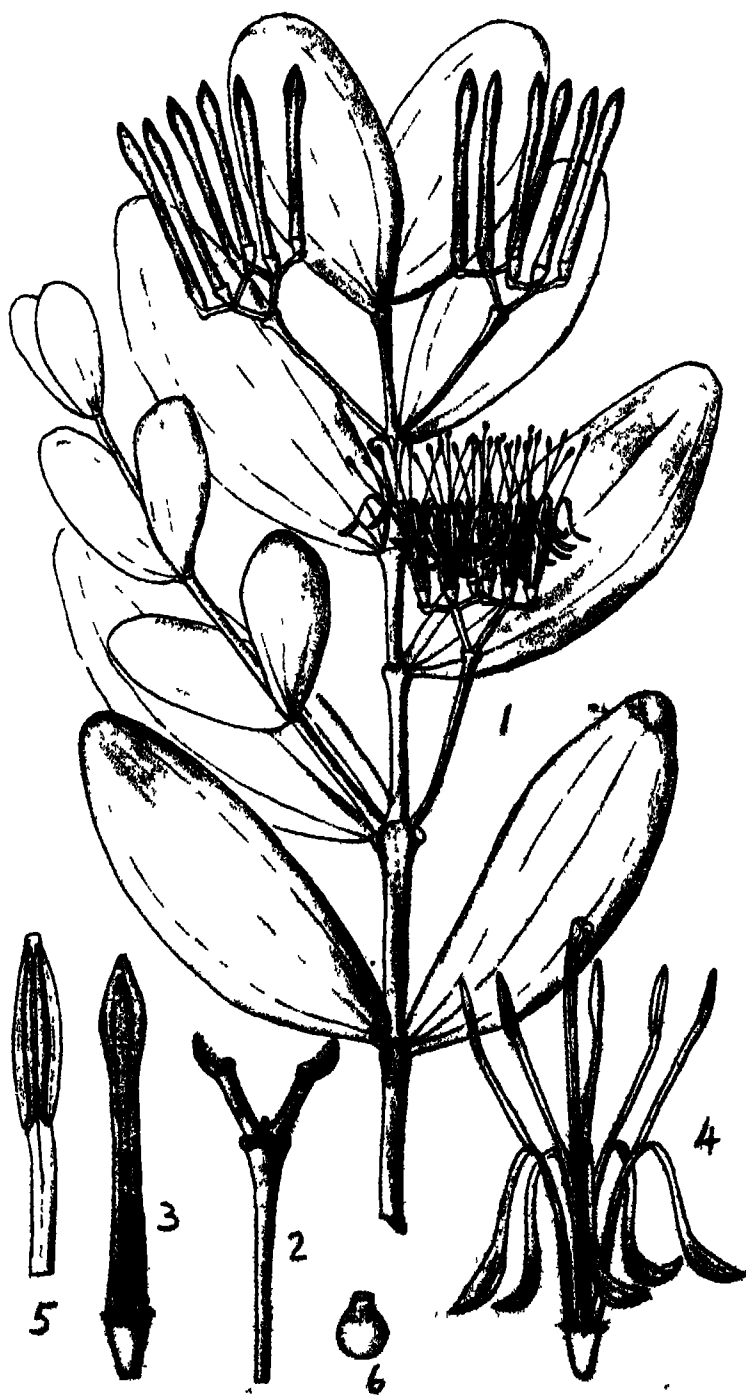
Loranthus conspicuus Bail

W F B del



A *Loranthus Belcheri*, n sp B *L. Belcheri*, var *dubia*, n var
C *L. Belcheri*, var *tomentilla*, n var

W F B del



Loranthus obliqua, n. sp.

W F B del



Microcachrys tetragona Showing general habit of the plant, with microspore cones Natural size



Fig 1—Group of mulgas (*Acacia aneura*) on rocky hill at Corona north of Broken Hill. Ground vegetation made up of species of *Bassia*.

Fig 2—*Acacia tetragonophylla* ('Dead-finish'). Ground flora species of *Bassia*.



Fig 3—Low hills near Corona with open mulga scrub. Corona creek with *Uncalyptus rostrata* in middle distance.

Plate xvi

Fig 4 *Sarcostemma australe* ("snake-bush" or "caustic-bush"), a leafless
Asclepiad growing on rocky slopes Broken Hill

Fig 5 - *Isotoma petraea* growing in clefts and between gneissic boulders
Broken Hill

Fig 6 — *Prostanthera striatiflora* with *Aristida* and *Psilopus obovatus* in right
foreground, illustrating the nature of the lower shrubs and undergrowth of the
Mulga scrub association Broken Hill

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Plate xvii

Fig 7 Low limestone hill with scattered mallee (*Eucalyptus callet*), ground flora made up entirely of species of *Kochia* and *Bassia* with *Zigophyllum frutescens* at the base of the trees Corona

Fig 8 —Slate outcrops near Old Corona on main stock route. Sparse vegetation of *Kochia sedifolia* and *K. pyramidalis* with ground covering of the grass *Schizanthus fasciculatus*. Rubble sheet of fragmental quartz uncolonised

Fig 9 —Limestone slope near Corona with open community of species of *Kochia*. The trees near summit of slope are *Casuarina lepidophloia*

7



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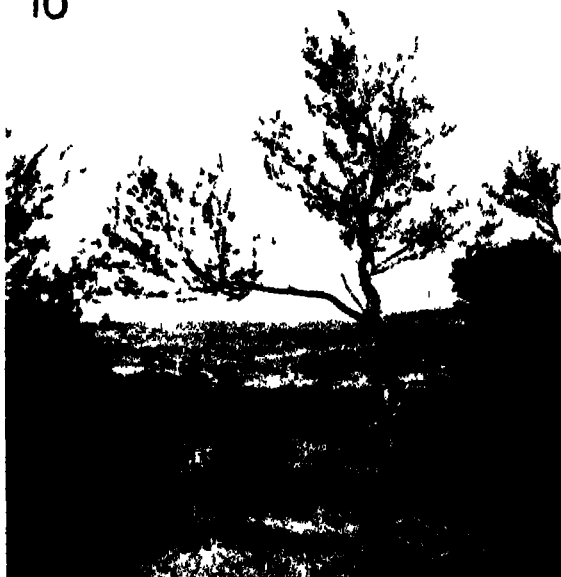
Plate xviii

Fig 10 --Mulga-dotted slopes near Corona with old mulga in foreground infected with *Uromycladium*

Fig 11 Solitary tree of *Lindera maculosa* (Leopard-wood) with ground flora of *Ko hia sedifolia* Between Purnamoota and The Paps, Barrier Range

Fig 12 --Flooded clayey flat behind creek showing colonisation by species of *Rassia*

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Plate XIX

Fig 13 Level sandy ground showing plants of *Chanthus Dampieri* (Sturt's Desert Pea) Broken Hill

Fig 14 —Single plant of *Chanthus Dampieri* indicating prostrate habit and manner of growth

Fig 15 —*Bassia paradoxa* colonising bare clayey soil between flood levels on a sandy creek



Plate xv

Fig 16—Depression in the Range between Broken Hill and Thackaringa—the Pinnacles in the distance—colonised chiefly by *Atriplex vesicarium* with *Kochia sedifolia* on higher ground

Fig 17—*Atriplex vesicarium* (Saltbush) plain with a few trees of *Acacia* sp and gum-creek (*Eucalyptus rostrata*) winding in distance

Fig 18 Typical barren hill close to Broken Hill *Kochia pyramidata* *Kochia triptera* and *K. sedifolia* and a few species of *Bassia* represent the only vegetation on the slopes and level ground and indicate dearth of annual vegetation during the 1922 season Note uncolonised rubble area

Fig 19—Saltbush plain with *Kochia aphylla* in the foreground and *Rhagodia spinescens* further away Level ground between shrubs covered with close mat-like colony of *Marsilea Drummondii* (Nardoo)

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Plate xxi

Fig 20- Colony of *Triodia irritans* ('Porcupine grass' or 'spinifex') near Stephen's Creek, Broken Hill

Fig 21 Single plant of *Triodia irritans* showing the formation of a typical hummock by the retaining of sand



Fig 20



Fig 21

Plate xxii

Fig 22—Stephens Creek near Broken Hill showing sandy bed and tall gums
(*Eucalyptus rostrata*)

Fig 23 Clay-pan lake bordered by black Box flat (*Eucalyptus bicolor*)
Langawirra

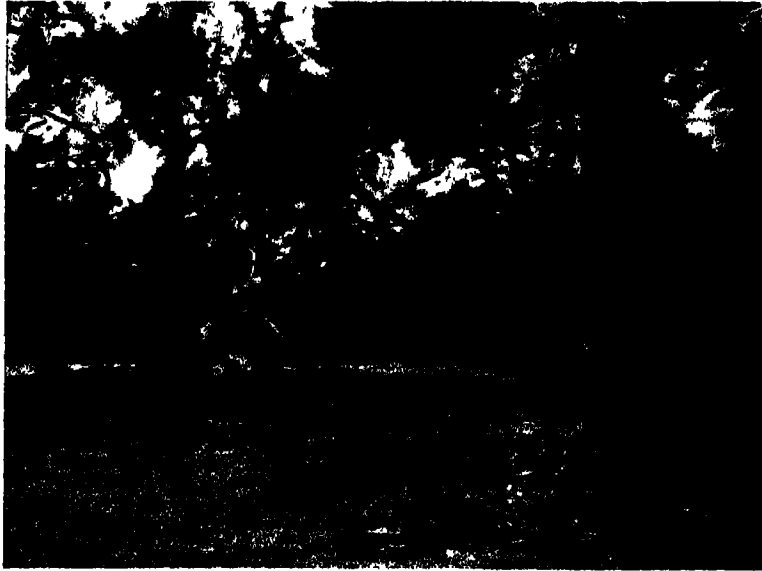


Fig 22



Fig 23.

Plate xxiii

Fig 24—Cobham Lake, a large clay-pan north of Broken Hill Drought stricken trees of *Eucalyptus bicolor* in foreground

Fig 25—Dry floor of Bancannia Lake, a clay-pan 100 miles north of Broken Hill—showing colonisation by *Bassia divaricata* and *Chenopodium nitroscum*



Fig 24

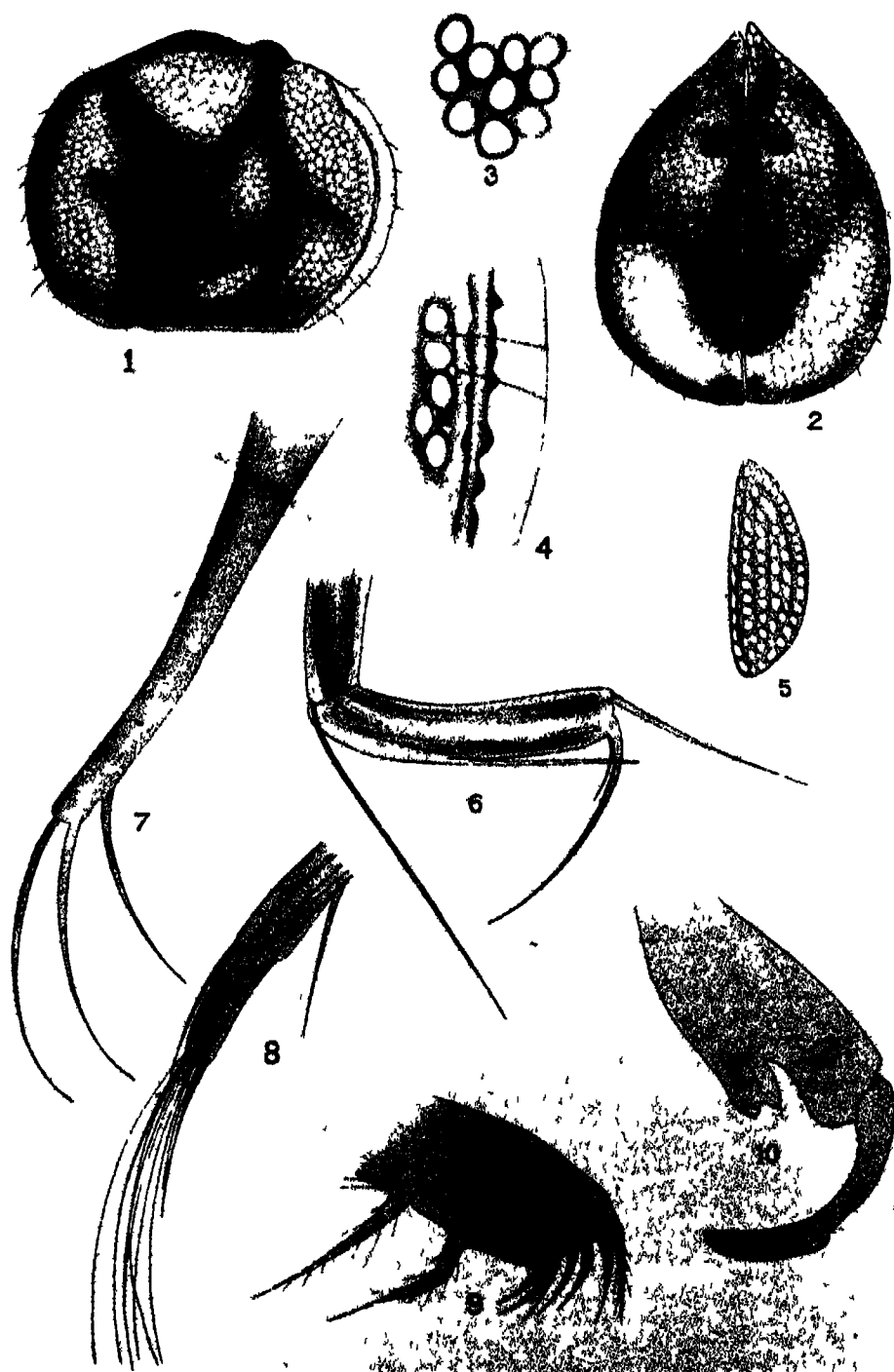


Fig 25

Plate xxiv

Newnhamia fenestrata

Fig 1—♀ Lateral view (x 60), Fig 2—dorsal view (x 60) Fig 3—surface markings (x 225) Fig 4—shell margin (x 225) Fig 5—ventral plate (x 60) Fig 6—end segment, second leg (x 225), Fig 7—furca (x 358), Fig 8—end of antenna (x 225), Fig 9—second maxilla (x 550) Fig 10—second maxilla ♂ (x 550)



Newnhamia fenestrata

Plate XXV

Cypridopsis australis, ♀

Fig. 1 —Lateral view (x 88), Fig. 2 —dorsal view (x 88), Fig. 3 —surface (x 200), Fig. 4 —antenna (x 408), Fig. 5 —first leg (x 550), Fig. 6 —second leg (x 550), Fig. 7 —furca (x 350)

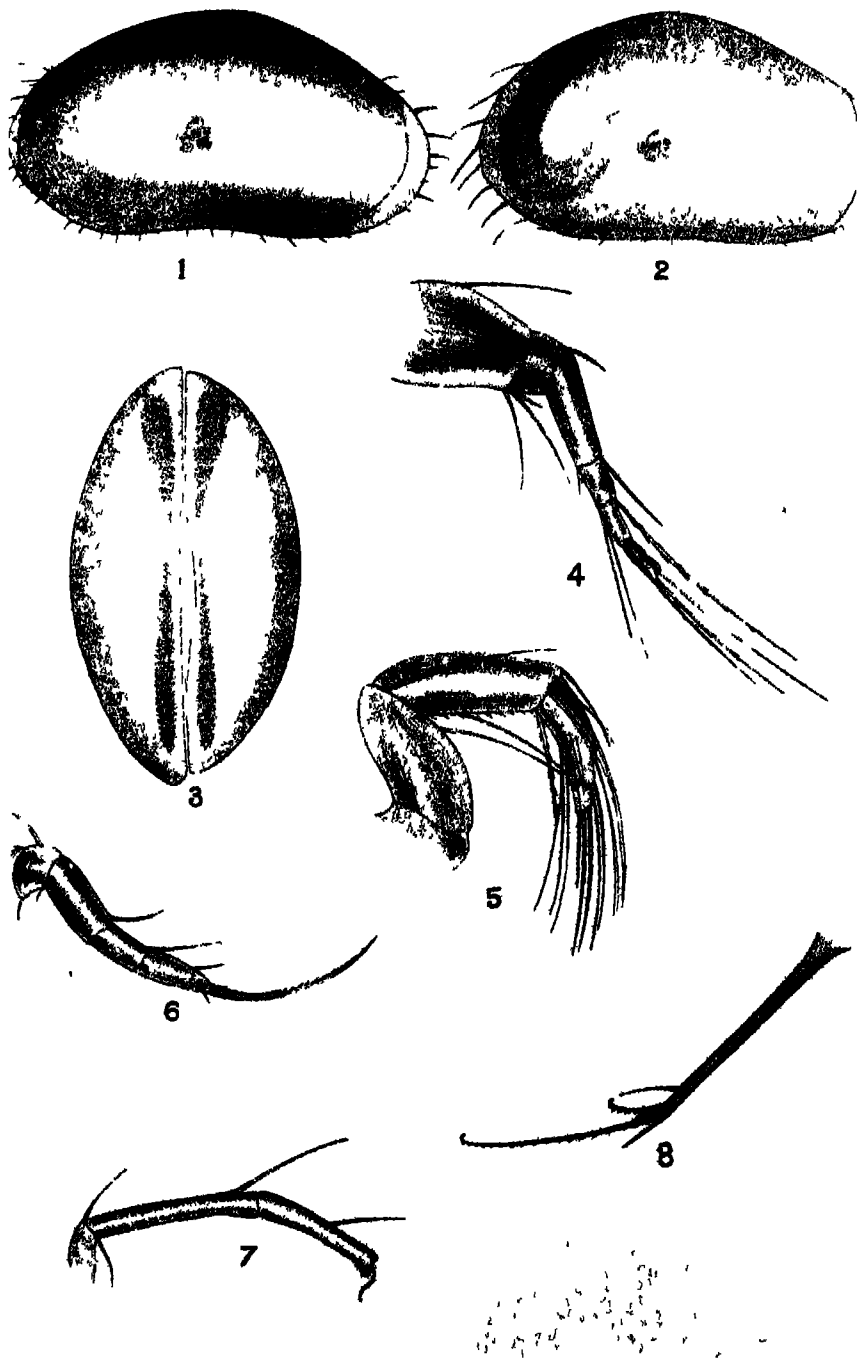


Cypridopsis australis, ♀

Plate xxvi

Cypris ermita

Fig 1 --♀ lateral view (x 25) Fig 2 --♂ lateral view (x 25), Fig 3 --♀ dorsal view (x 25), Fig 4 --♀ antennule (x 62) Fig 5 --♀ antenna (x 62) Fig 6 --♀ first leg (x 70), Fig 7 --♀ second leg (x 70), Fig 8 --♀ furca (x 50)



Cypris orinota

Plate XXXII

Cyprinotus tenuis, ♀

Fig 1 Lateral view (x 67) Fig 2 dorsal view (x 67) Fig 3 —surface
(x 270) Fig 4 antenna (x 166) Fig 5 antennule (x 166) Fig 6 —first leg
(x 166) Fig 7 —second leg (x 166) Fig 8 —furca (x 170)



Cyprinotus tenuis, ♀

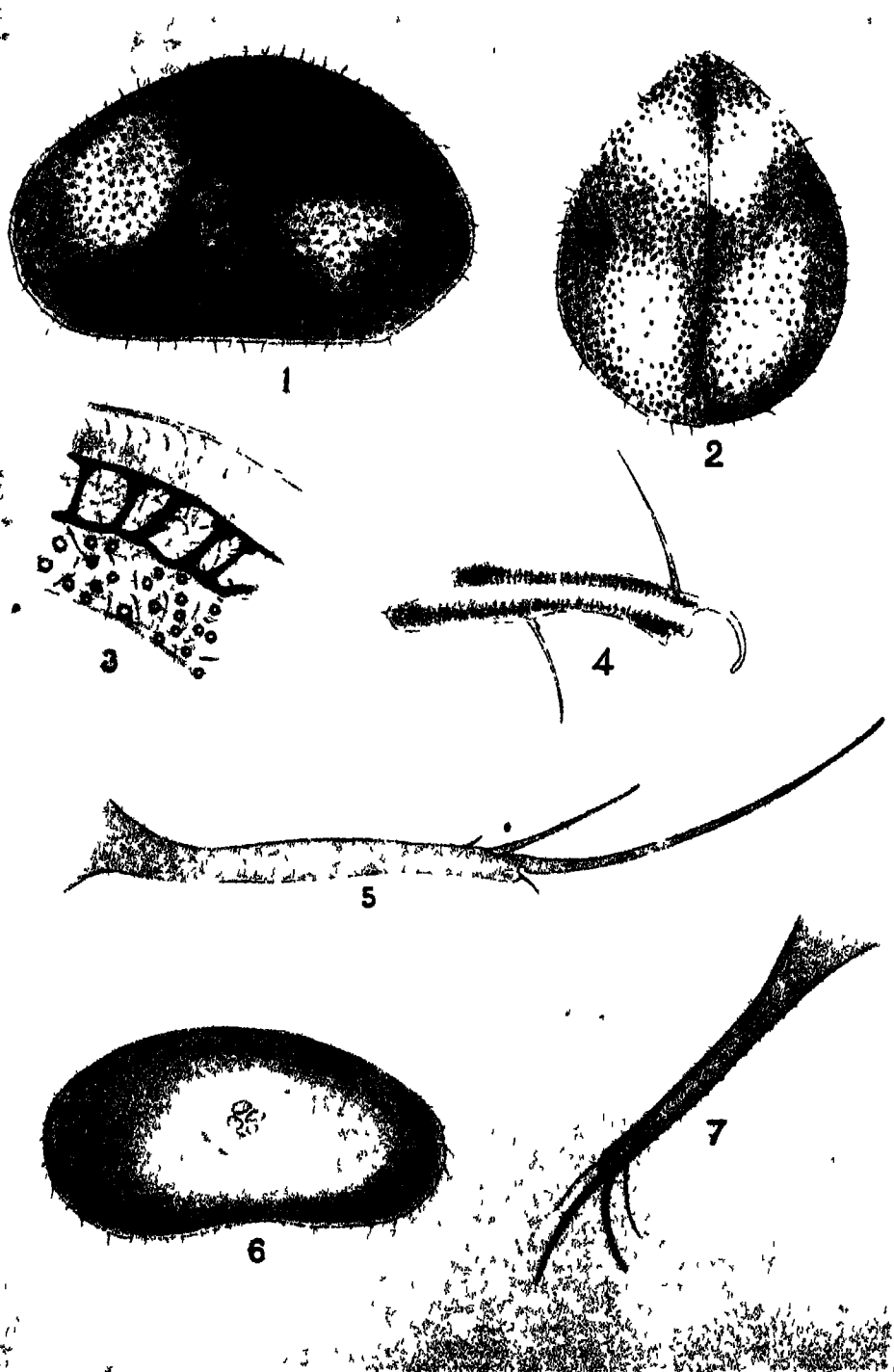
Plate XXVIII

Figs 1-5 *Cypretta hirsuta*, ♀

Fig 1 - Lateral view (x 105), Fig 2 dorsal view (x 105) Fig 3 --valve margin (x 210) Fig 4 --end segment, second leg (x 525) Fig 5 furca (x 525)

Figs 6-7 *Herpetocypria laevissima*, ♀

Fig 6 Lateral view (x 72) Fig 7 --furca (x 100)



1-5 *Cypretia hirsuta*, ♀ 6-7 *Herpetocypris laevissima*, ♀

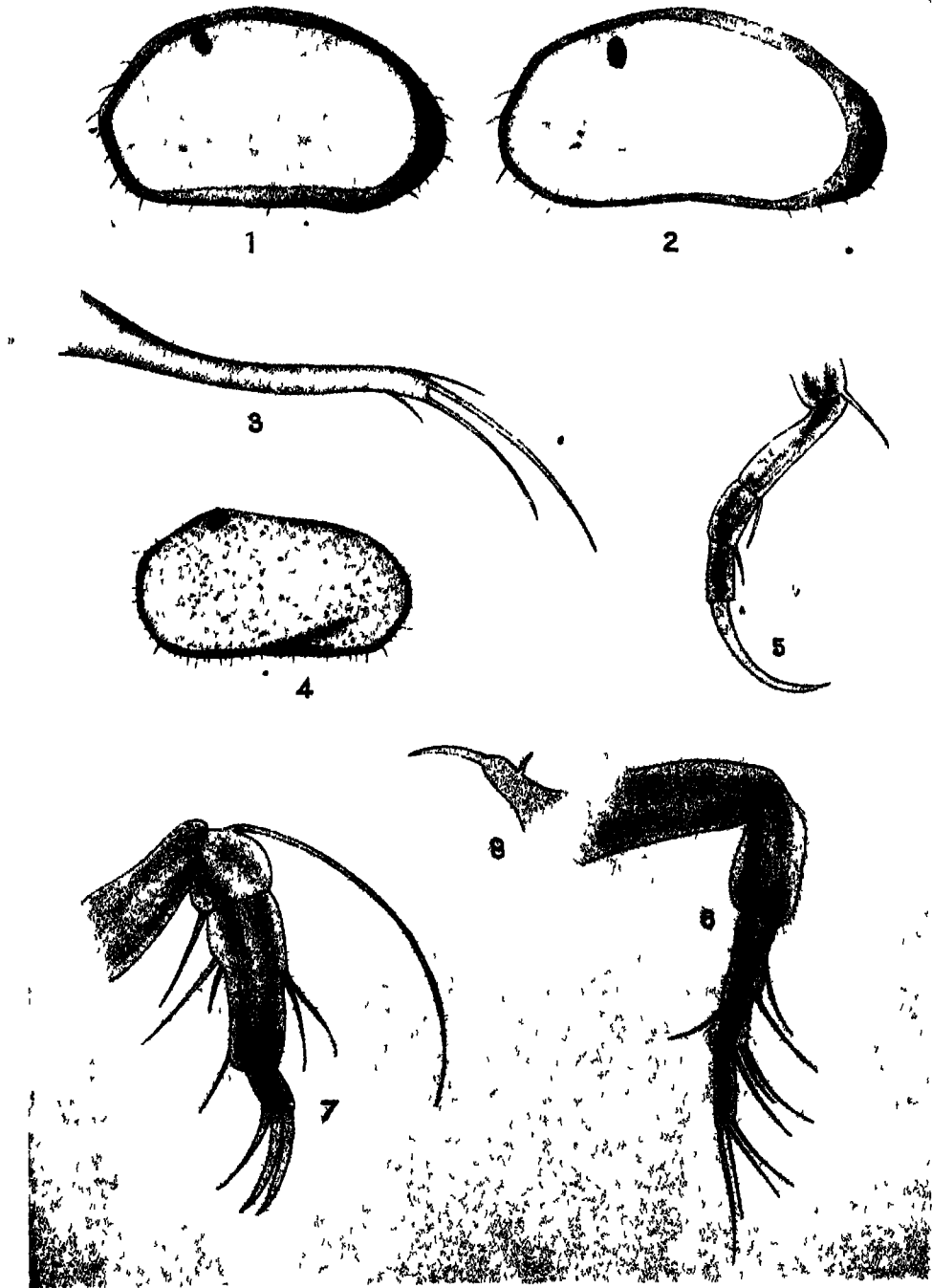
Plate XXIX

Figs 1-3 *Cyclocypris tenuissima*

Fig 1 ♂ Lateral view (x 94) Fig 2 —♀ lateral view (x 94), Fig 3 —
♀ furca (x 468)

Figs 4-8 *Limnocythere aspera* ♀

Fig 4 - Lateral view (x 94) Fig 5 -first leg (x 450) Fig 6 antennule
(x 150) Fig 7 antenna (x 450) Fig 8 - furca (x 450)

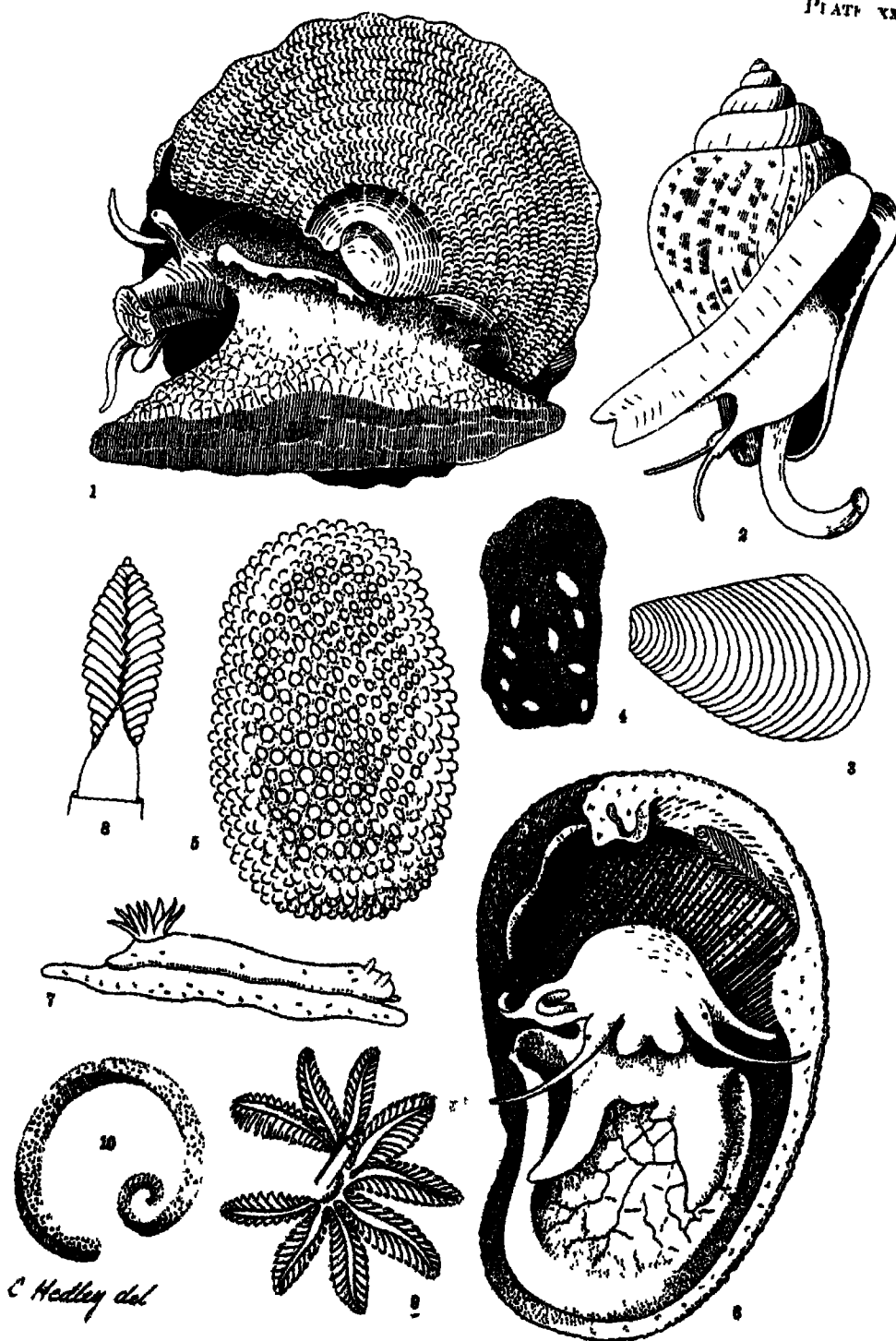


1-3 *Cyclocypris tenuissima*.

4-8. *Limnocythere aspera*, ♀

Plate xxx

- Fig 1 —*Astraea sirius* Gould, animal from life
- Fig 2 —*Pyrene versicolor* Sowerby var *atludona* Duclou, animal from life
- Fig 3 —Operculum of same
- Fig 4 —*Nerita melanotrugus* Smith, egg masses laid on a pebble
- Fig 5 —A single egg mass of the above, enlarged
- Fig 6 —*Crepidula aculeata* Gmelin, animal from life
- Fig 7 —*Chromodoris bennetti* Angas, animal from life
- Fig 8 —Rhizophore of same enlarged
- Fig 9 —Branchiae of same enlarged
- Fig 10 —Egg mass of same

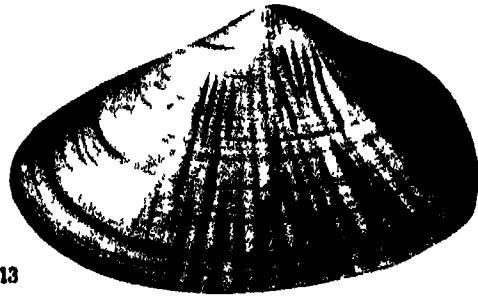


. Plate XXXI

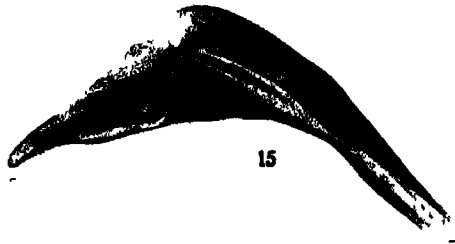
- Fig 11 -- *Trgonauta böltgeri* Maltzan
Fig 12 -- *Cerithium dorsuosum* Menke
Fig 13 -- *Hemidonax dactylus* Hedley, type
Fig 14 -- *Pitaria inconstans* Hedley, type
Fig 15 -- Hinge of same
Fig 16 -- Dorsal view of same enlarged
Fig 17 -- *Pseudarcopagia botanica* Hedley
Fig 18 -- Hinge of same
Fig 19 -- Enlarged sculpture of same



12



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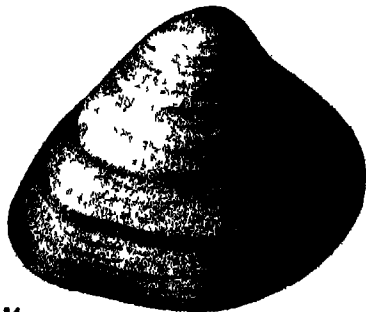
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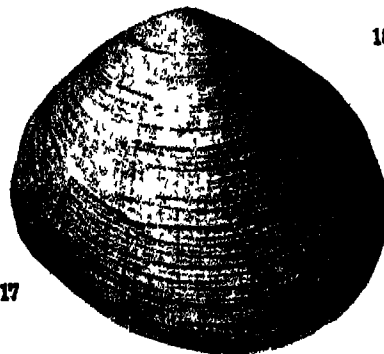
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14



17

Phyllus & Clava

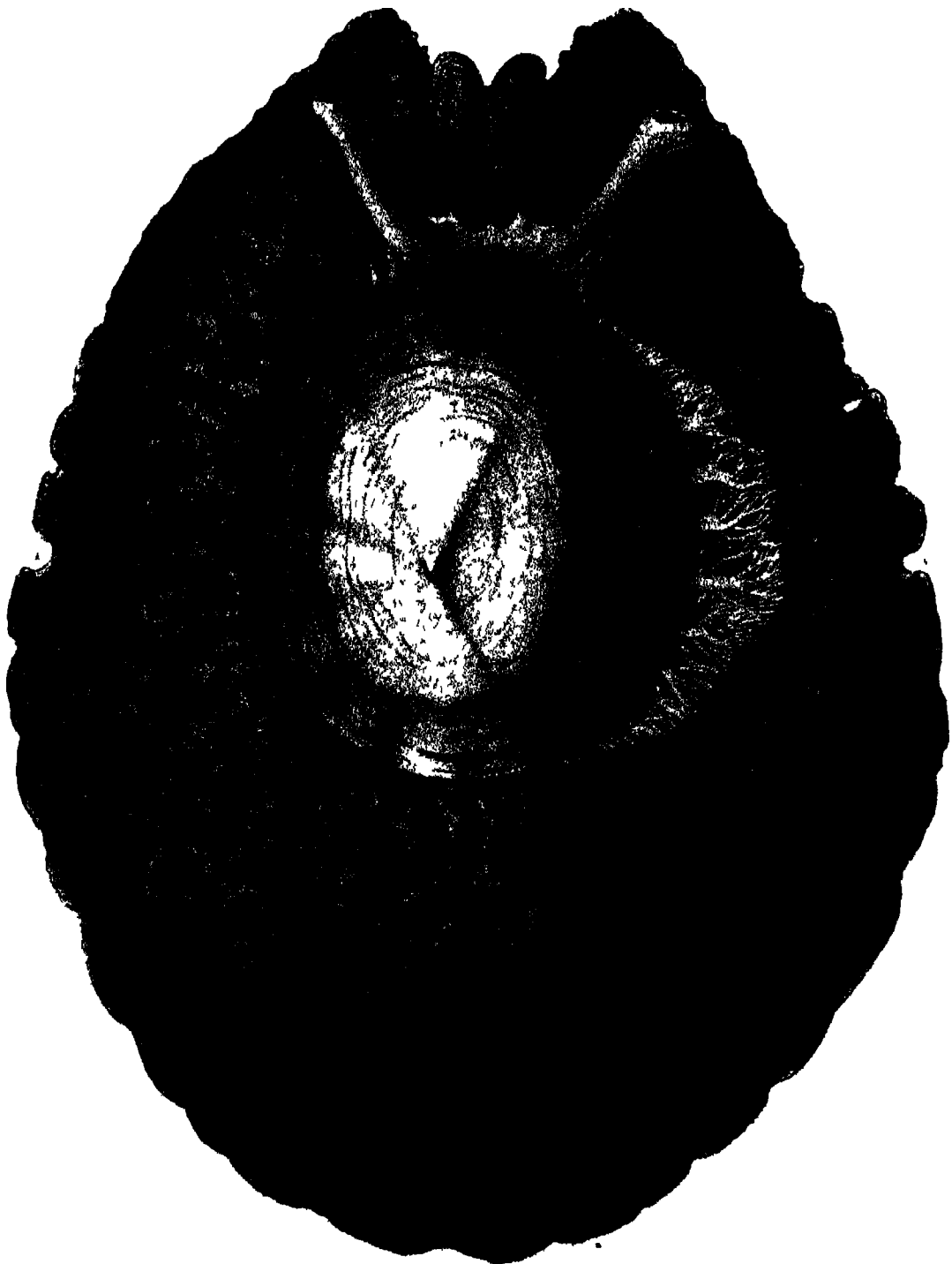


Plate xxxii

Fig. 21. *Lethys angasi* Sowerby



Fig 21 —*Tethys angasi* Sowerby



Bassia patentiuspis, n.sp

A Branch B Fruiting perianth C Vertical section of fruting perianth showing position of seed

Bassia obliquicuspis, n.sp

D. Branch E Top view of fruting perianth F Basal and lateral view of fruting perianth G Vertical section of fruting perianth showing position of seed.

Bassia parallelcuspis, n.sp

H. Branch I Side view of fruting perianth K Basal view of fruting perianth L Vertical section of fruting perianth showing position of seed

Plate xxxv

Bassia tubata, n. sp.

A Portion of plant B Fruiting perianth C Vertical section of fruiting
perianth showing position of seed
Coonamble E Breakwell 1918

Bassia intricata, n. sp.

D Branch E Fruiting perianths in situ on the stem F Vertical section
of the fruiting perianth showing position of the seed
Mutooroo, S.A. A Morris No 635 Aug 1921



Plate xxxvi

Bassia concolorata, n sp

A Branch B Fruiting perianth C Section of the fruiting perianth showing position of the seed
Cobar L Abrahams, Aug 1911

Bassia costata, n sp

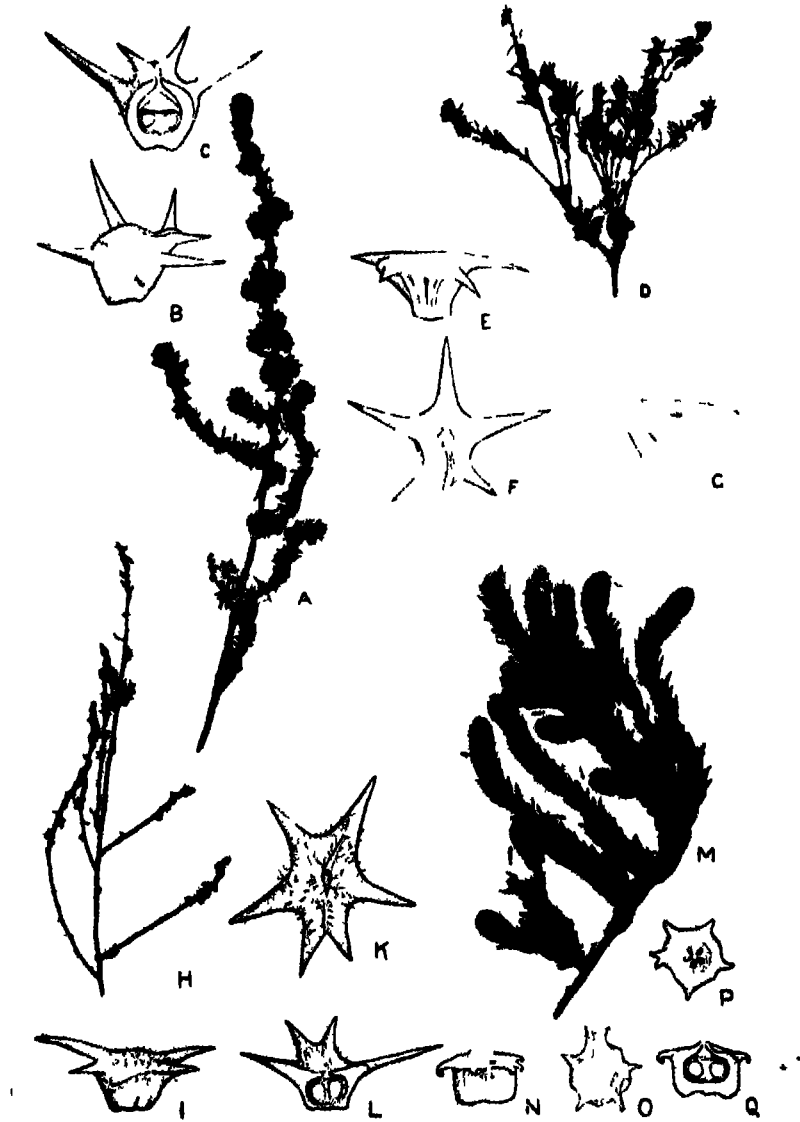
D Portion of plant E F Side and top view of fruiting perianth G Vertical section of the fruiting perianth showing position of the seed
Sixty miles NE C 2 N Territory G F Hill, June 1911

Bassia parviflora n sp

H Branch I K Side and top view of fruiting perianth L Vertical section of fruiting perianth showing position of the seed
Minnipa S A J M Black Nov , 1915

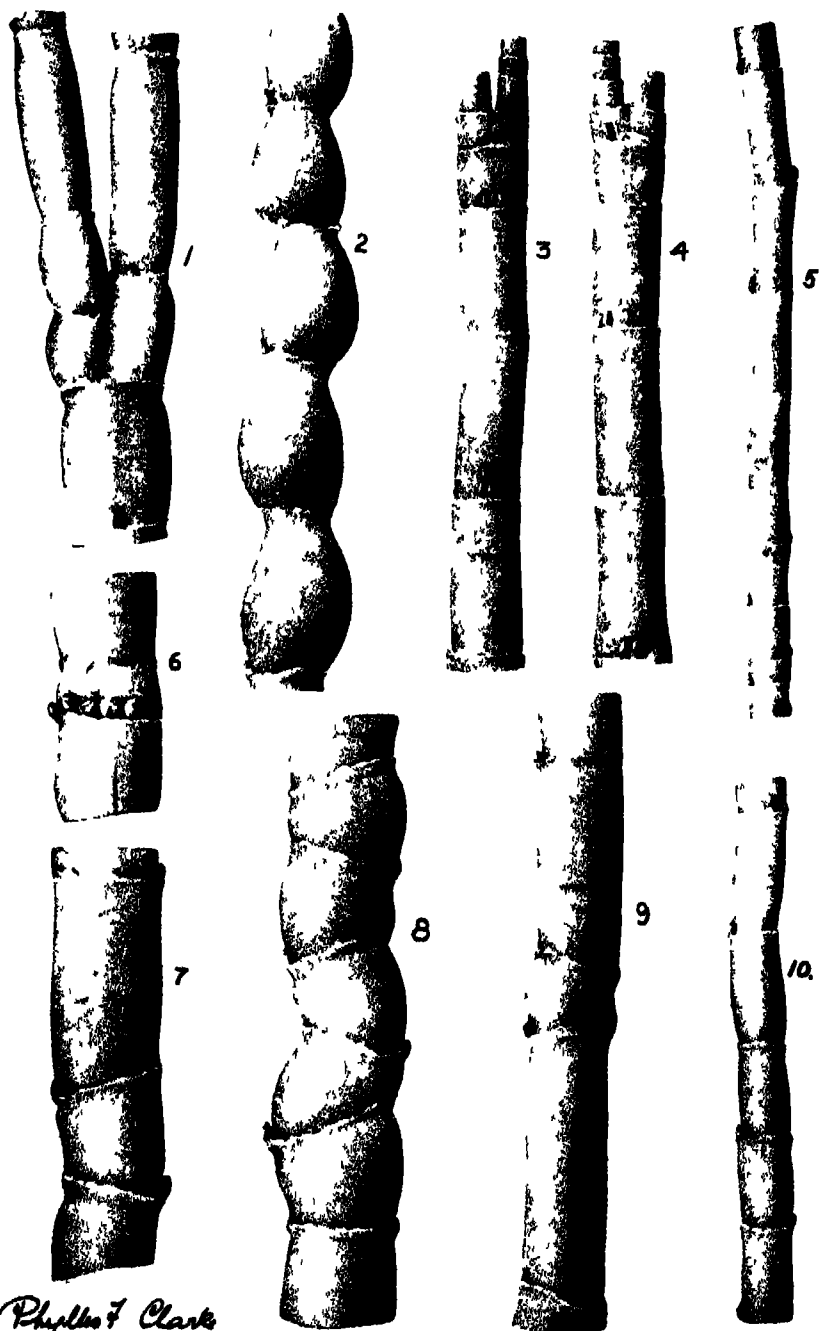
Bassia microcarpa, n sp

M Portion of plant N Side view of fruiting perianth O Top view of fruiting perianth P Bottom view of fruiting perianth Q Section of fruiting perianth showing position of the seed
Poison Creek via Leonora, W A A A McGregor Sept 1909



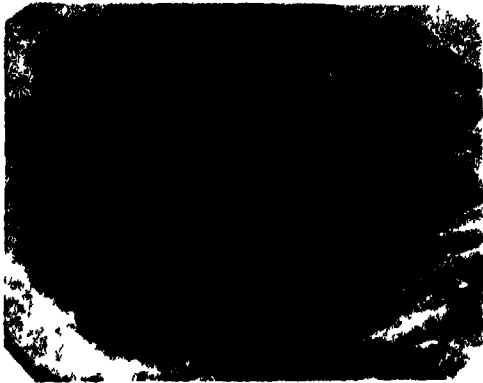


Callitris Baileyi, n. sp.



Phyllis F. Clark

Some abnormal sugar-canes. (x $\frac{1}{2}$)



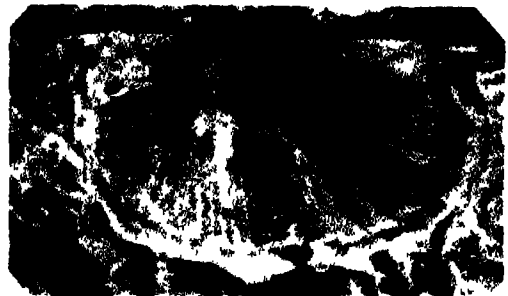
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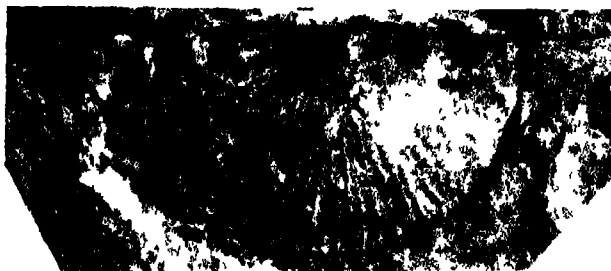


7



8

Species of *Stropheodonta* from Bowring, N S W



9



10



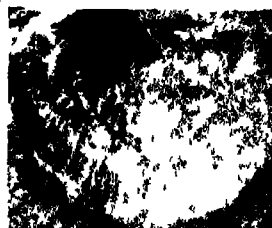
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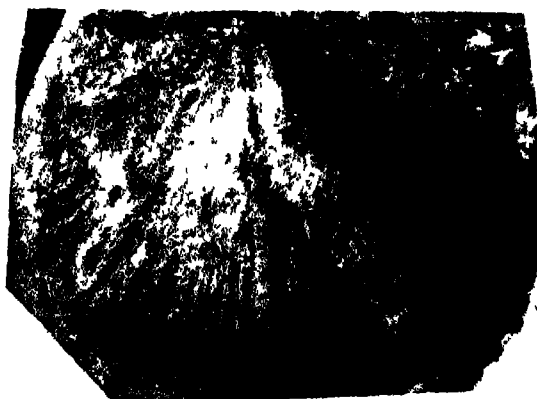
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16

Species of *Strephodontia* from BOWRING, N S W



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21



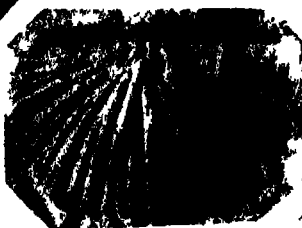
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23



26



24

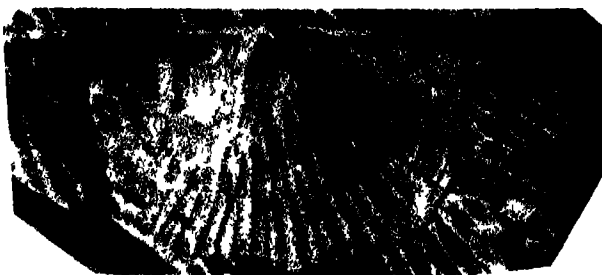


25

Species of *Strophodontia* from Bowring, N S W



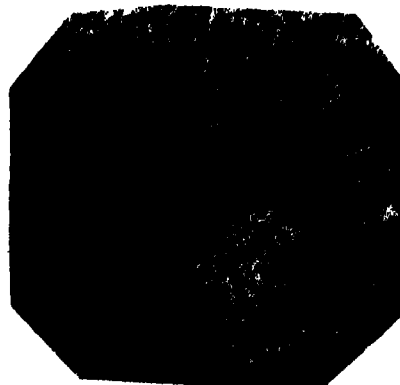
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28



29



30



31

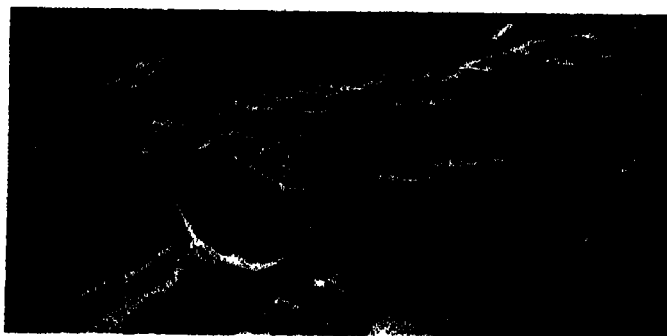


32



33

Species of *Stropheodonta* from Bowring, N S W



38



39

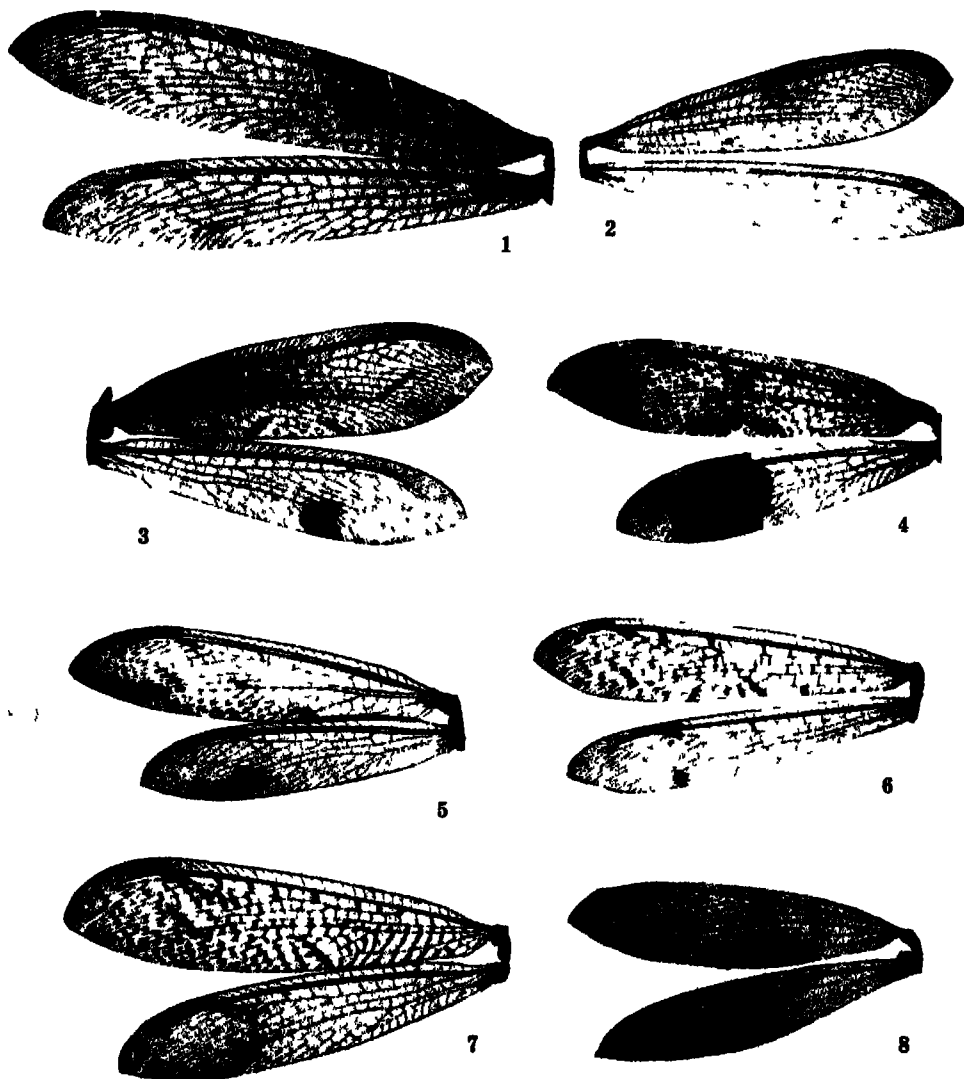


40

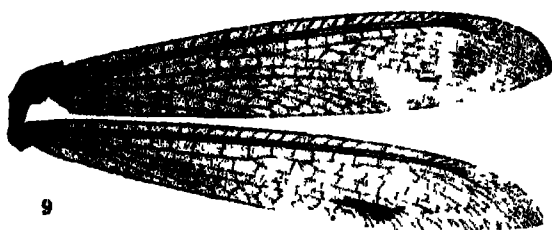
38 *Ipsuvicia jonesi* 39-40 *Oxmylopsychops spilleræ*



Pterosphaera Fitzgeraldi F v M



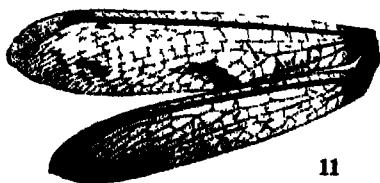
Australian Myrmeleonidae



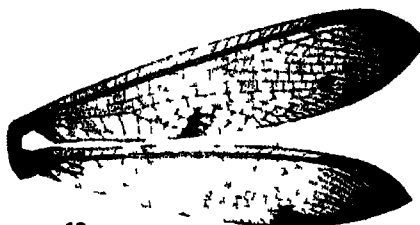
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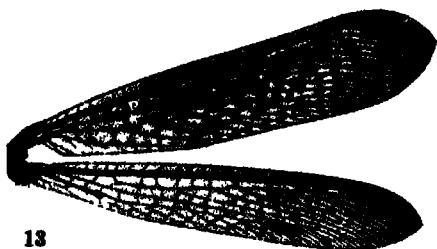
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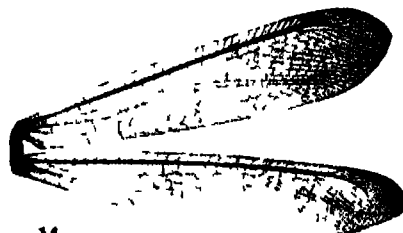
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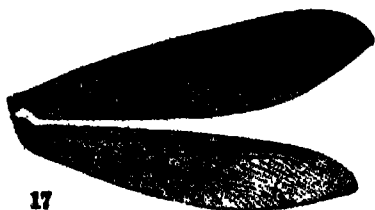
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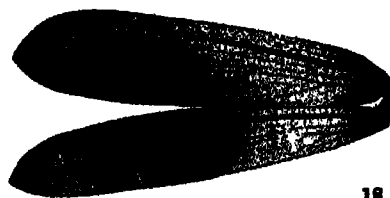
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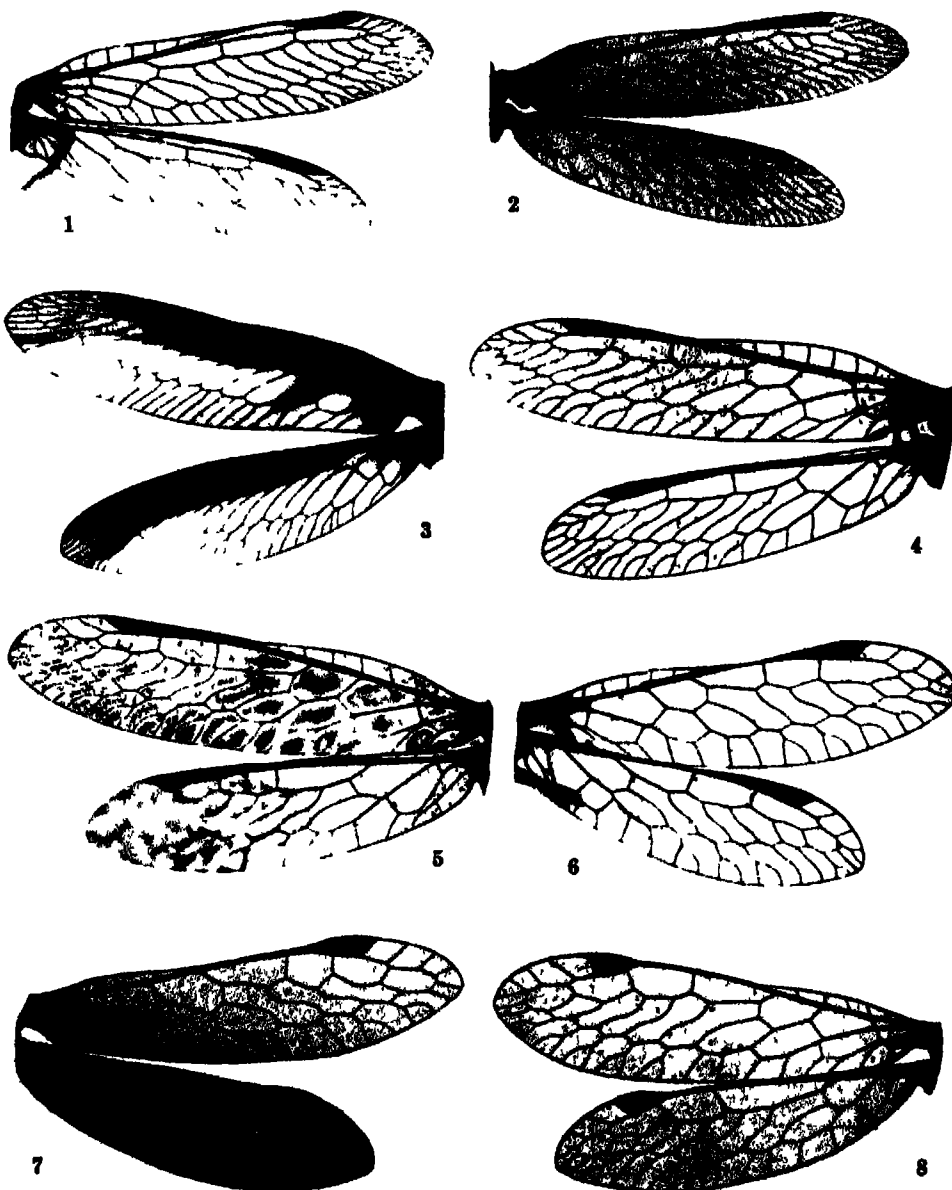


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18

Australian Myrmeleonidae



Australian Mantispidæ



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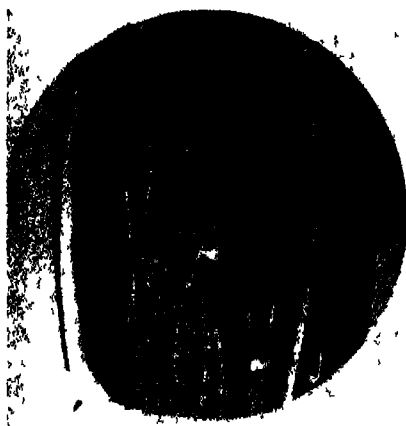
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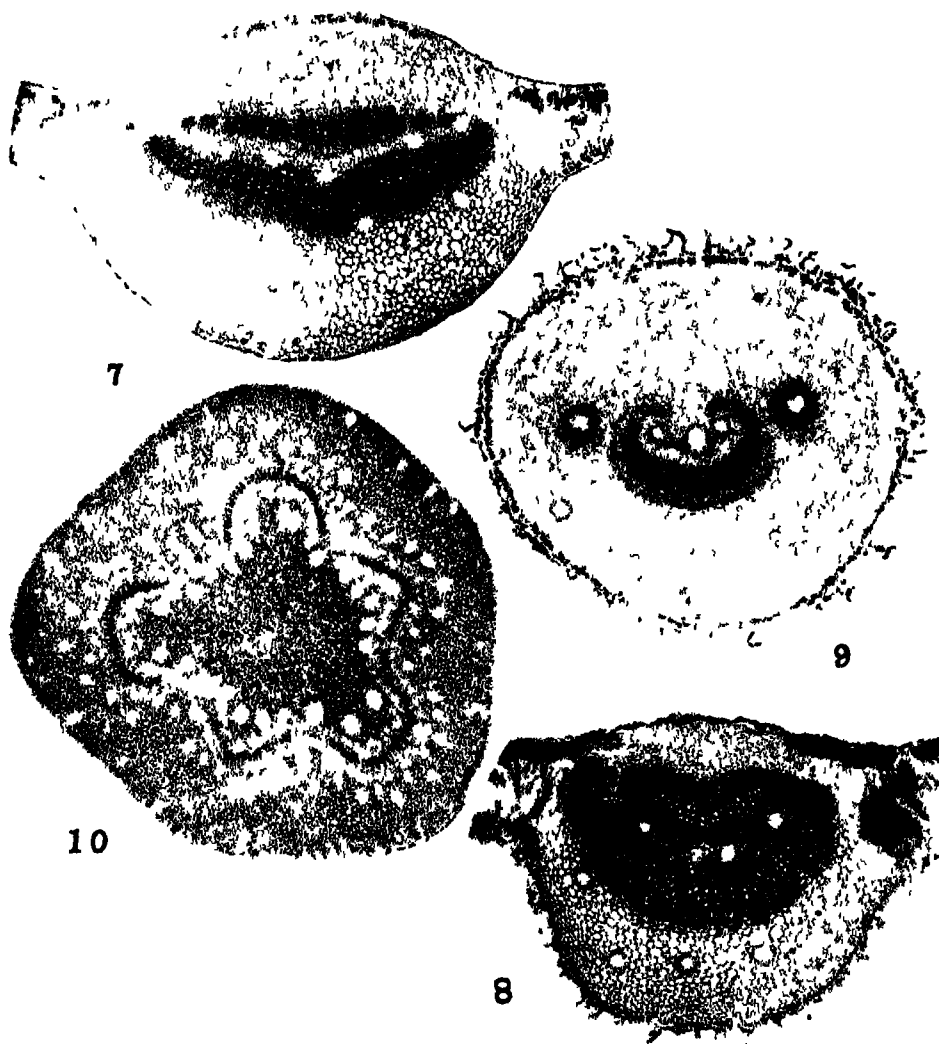


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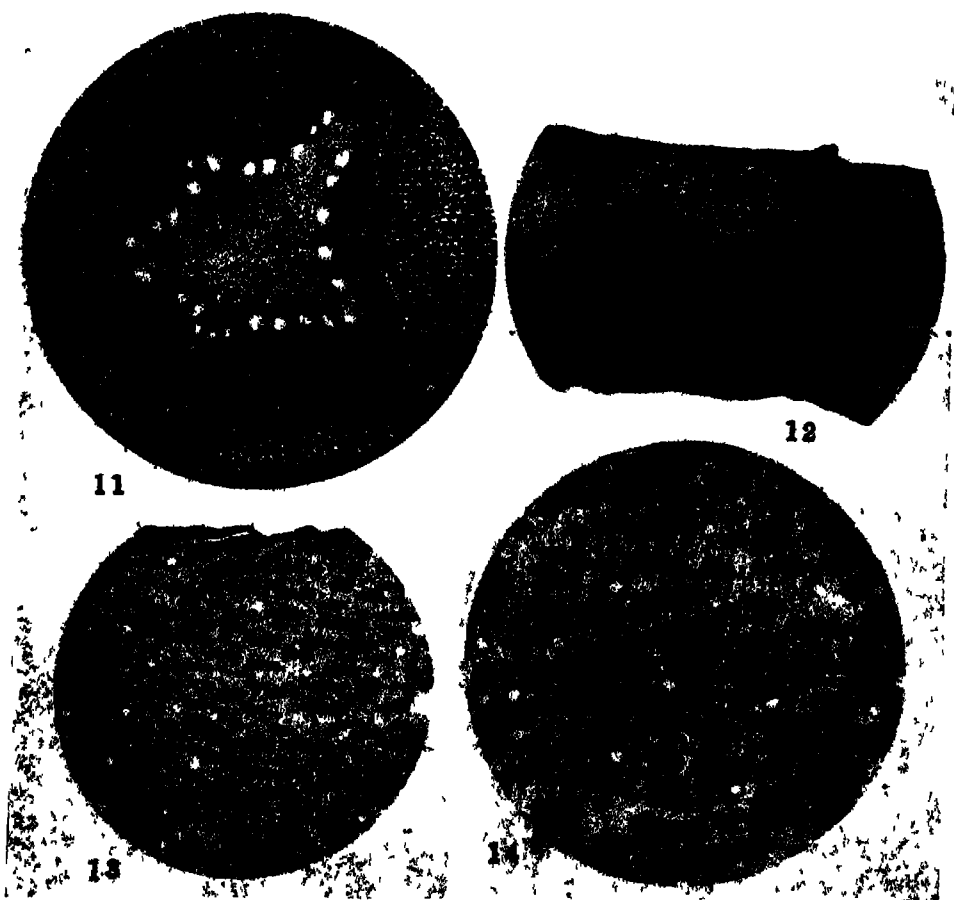


6

Tristania conferta.



7, 10 *Tristania conferta* 8, 9 *Syncarpia laurifolia*



11, 13 *Tristania conferta*

12, 14 *Syncarpia laurifolia*

I. A. R. I. 75.

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